SITE: Medley Farm
BREAK: 8b
OTHER: 57

Third Five-Year Review Report
Medley Farm Drum Dump Superfund Site
Gaffney, Cherokee County, South Carolina

September 2009

PREPARED BY:

U.S. Environmental Protection Agency
Region 4

Approved by: _____
Franklin E. Hill, Director
Superfund Division
U.S. EPA, Region 4

Date: 9/1/09

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List of Acronyms

ARAR	Applicable or Relevant and Appropriate Requirement
COC	Contaminant of Concern
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (1980), as amended
CIC	Community Involvement Coordinator
COC	Contaminant of Concern
DP	Dual Phase
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Difference
IC	Institutional Control
MCL	Maximum Contaminant Level
NCP	National Contingency Plan
NPDES	National Pollution Discharge Elimination System
NPL	National Priorities List
O&M	Operation and Maintenance
PRP	Potentially Responsible Party
PSVP	Performance Standards Verification Plan
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RAO	Remedial Action Objective
RD	Remedial Design
RG	Remedial Goal
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
SCDHEC	South Carolina Department of Health and Environmental Control
UIC	Underground Injection Control
VOC	Volatile Organic Compound

Executive Summary

The Medley Farm Site is a 7-acre portion of a 61.9 acre parcel of rural land located on Burnt Gin Road about six miles south of Gaffney, South Carolina in Cherokee County. Land use in the Site vicinity is primarily agricultural and light residential.

Prior to the mid 1970's, the property was maintained as woods and pasture land. From approximately 1973 to 1976, a number of area textile, paint, and chemical manufacturing firms disposed of their industrial wastes on the Medley property. The Site was first documented in 1981 when a firm disposing of wastes at the Site reported its use of the Medley Farm Site to the United States Environmental Protection Agency (EPA). EPA initiated a removal action on June 20, 1983. A total of 5,383 55-gallon drums and 15-gallon containers were removed from the Site. Approximately 24,000 gallons of liquids from the drummed waste were taken off-site by tanker and incinerated. Some 2,132 cubic yards of solid waste and contaminated soils were taken to an approved hazardous waste landfill. About 70,000 gallons of water were drained from six small lagoons and transported offsite for proper disposal.

A Remedial Investigation/Feasibility Study (RI/FS) determined that the soil was contaminated with volatile organic compounds (VOCs) in three primary areas. Groundwater was found to be contaminated with VOCs. EPA issued a Record of Decision (ROD) on May 29, 1991, selecting a Site remedy. Extraction and on-site treatment of contaminated groundwater via air stripping (groundwater pump-and-treat) was selected as the groundwater remedy component. Treated water would be discharged to Jones Creek via a National Pollution Discharge Elimination System (NPDES) permit. Soil Vapor Extraction (SVE) was selected to remove contaminants from the soil and prevent leaching of them to groundwater. Analytical monitoring of groundwater and surface water would be performed as part of the remedial action.

In September 1993, EPA approved the remedial design for cleanup of the Medley Farm Site. During 1993-94 an 11-well pump-and-treat system for groundwater was constructed, which employs a central air stripping unit. A low-profile air-stripping unit removes volatile organic compounds (VOCs) from groundwater. Also during this period an SVE system of 8 vapor extraction wells piped to a central vacuum apparatus was constructed, to remove VOCs from three main areas of soil contamination. These two systems operated between January 1995 and September 2004, with some enhancements to each system between 1998 and 2001. EPA completed the First Five-Year Review in 1999. No issues requiring action were found as a result of the First Five-Year Review.

In September 2004 EPA and the South Carolina Department of Health and Environmental Control (SCDHEC) approved cessation of both pump-and-treat operations and SVE operations. Declining performance from the pump-and-treat system had been recorded, and for Site soils, the cleanup goals were shown to have been attained by sample testing in accordance with the site's Performance Standards Verification Plan (PSVP).

Concurrently, EPA and SCDHEC approved the PRPs' work plans for a Supplemental Remedial Action (RA) for groundwater, which utilizes an enhanced reductive dechlorination (insitu biodegradation) treatment process. The supplemental RA is a "technical maximization" or optimization measure intended to accelerate remedy completion. Site wells and the Site monitoring program are used to evaluate the effectiveness of the Supplemental RA activities, in comparison to the greatly-reduced effectiveness of the pump-and-treat system observed in 2004. Then activities focus on the use of enhanced reductive dechlorination, which is performed as groundwater injection events in which nutrient (lactate) solutions are mixed onsite and placed into select groundwater wells. After each injection, a variable period of time is allowed for groundwater equilibrium to be restored, during which field measurements may be made, followed by a sampling event to determine the effects and influence of the treatment.

EPA and SCDHEC completed the Second Five-Year Review in September 2004. Seven issues were identified, of which two were judged capable of affecting remedy protectiveness. The main issue was completion and approval of plans for the Supplemental RA. The remaining six issues resulted from observations made during the site inspection. All six issues were addressed and resolved by the date specified in the Second Five-Year Review Report (Dec. 31, 2004).

The Site RA (Supplemental RA) activities have continued since 2004. EPA and SCDHEC reviews of the reports and analytical data generated from continued injections and monitoring indicate that Contaminant of Concern (COC) concentrations in groundwater continue to decrease.

Five issues were identified in this Third Five-Year Review Report. Four of the issues could affect remedy protectiveness in the future, but none of the issues affect current protectiveness.

The remedy at the Medley Farm Site currently protects human health and the environment because the soil cleanup goals were attained in 2004, the groundwater remediation is continuing to decrease the concentrations of COCs, and no one is currently drinking water from the contaminated groundwater plume. However, in order for the remedy to be protective in the long term, the following actions need to be taken: modify the decision document to incorporate the requirement for Institutional Controls (ICs), modify the decision document to modify the remedial action for groundwater, conduct a vapor intrusion assessment, and revise and update the Quality Assurance Project Plan.

Since ongoing remedial action has not achieved the cleanup standards set forth in the ROD, a Five-Year Review Report will be necessary to re-evaluate the effectiveness of the remedy on or before five years from the date of signature of this Five-Year Review Report.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name: Medley Farm Drum Dump		
EPA ID: SCD 980 558 142		
Region: 4	**State:** SC	**City/County:** Gaffney / Cherokee County

SITE STATUS	
NPL status: X Final ☐ Deleted ☐ Other (specify)	
Remediation status (choose all that apply): ☐ Under Construction X Operating ☐ Complete	
Multiple OUs? ☐ YES X NO	**Construction completion date:** 09 / 29/ 1995
Has site been put into reuse? ☐ YES X NO	

REVIEW STATUS	
Lead agency: X EPA ☐ State ☐ Tribe ☐ Other Federal Agency	
Author name: Ralph O. Howard, Jr.	
Author title: Remedial Project Manager	**Author affiliation:** US EPA Region 4
Review period: 05 / 27 / 2004 to 09 / 01/ 2009	
Date(s) of site inspection: 01 / 21 / 2009	
Type of review: X Post-SARA ☐ Pre-SARA ☐ Non-NPL Remedial Action Site ☐ Regional Discretion	☐ NPL-Removal only ☐ NPL State/Tribe-Lead
Review number: ☐ 1 (first) ☐ 2 (second) X 3 (third) ☐ Other (specify)	
Triggering action: ☐ Actual RA On-site Construction at OU # ☐ Construction Completion ☐ Other (specify)	☐ Actual RA Start at OU# X Previous Five-Year Review Report
Triggering action date: 09 / 30 / 2004	
Due date: 09 / 30 / 2009	

Five-Year Review Summary Form cont'd.

Issues:

Five issues were identified in this Third Five-Year Review Report. The first four of the issues could affect remedy protectiveness in the future, but none of the issues affect current protectiveness. Issues found in this Third Five-Year Review were:

1. A revised and updated Quality Assurance Project Plan (QAPP) is needed to document the quality assurance activities that are being performed for the RA.
2. The Site remedy needs to be modified in order to incorporate the requirement for institutional controls (ICs).
3. Site remedy needs to be modified to select an appropriate remedial technology, considering enhanced insitu biodegradation and other feasible technologies, to continue the Site remedial action.
4. A determination is required as to whether the vapor intrusion pathway is of concern at the Site.
5. Materials at information repository are out of date and need to be augmented with more information for the public about the RA, and about how to access more information from EPA.

Recommendations and Follow-up Actions:

1: Current QAPP to be revised and updated to document QA activities performed in the RA.
2: Conduct remedy modification through either an ESD or ROD Amendment process, to incorporate the requirements for ICs.
3: Conduct remedy modification through either an ESD or ROD Amendment process, to select an appropriate remedial technology for continuing Site RA.
4: Conduct technical evaluation to determine if vapor intrusion is of concern at the Site.
5: As part of the remedy modification requirements, provide documents concerning the RA, as well as directions for access of information via the Internet, to the repository.

Protectiveness Statement(s):

The remedy at the Medley Farm currently protects human healthy and the environment because the soil cleanup goals were attained in 2004, the groundwater remediation is continuing to decrease the concentrations of COCs, and no one is drinking water from the contaminated groundwater plume. However, in order for the remedy to be protective in the long term, the following actions need to be taken: modify the decision document to incorporate the requirement for Institutional Controls, modify the decision document to modify the remedial action for groundwater, conduct a vapor intrusion assessment, and revise and update the Quality Assurance Project Plan.

Section 1. Introduction

This is the third Five-Year Review Report prepared for the Medley Farm Drum Dump Superfund Site in Gaffney, Cherokee County, South Carolina. The purpose of a Five-Year Review is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of the evaluation are documented in Five-Year Review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and identify recommendations to further evaluate and address them as necessary.

The Agency is preparing this Five-Year Review report pursuant to the Comprehensive Environmental Response, Compensation and Recovery Act (CERCLA) §121 and the National Contingency Plan (NCP). CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The Agency interpreted this requirement further in the NCP; 40 CFR §300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

EPA Region 4 has conducted this Five-Year Review of the remedy implemented at the Medley Farm Site in Gaffney, South Carolina. This review was conducted for the Site from January 2009 through July 2009. This report documents the results of the review.

The triggering action for this statutory review is the completion and signing of the second Five-Year Review on September 30, 2004. The Five-Year Review is required due to the fact that hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure.

Section 2. Site Chronology

Table 1: Chronology of Site Events

Event	Date
Disposal of hazardous materials onsite	1973-76
SCDHEC observes approximately 2,000 55-gallon drums on-site; collects soil samples for analysis	05/03/1983
EPA visits the Site and collects additional samples for analysis	05/30/1983
An immediate removal action is initiated by EPA	06/20/1983
EPA removal action is completed	07/21/1983
The United States files a complaint in a cost recovery action against the owner of the Site and various waste generators	06/1986
Preliminary Assessment performed	04/29/1987
The PRPs enter into an Administrative Order on Consent to perform the RI/FS	01/29/1988
The Medley Farm Site is placed on the National Priorities List (NPL)	03/31/1989
EPA issues a Record of Decision	05/29/1991
Remedial design begins	11/26/1991
Consent Decree is lodged by the Department of Justice	03/27/1992
EPA approves the remedial design for cleanup of the Medley Farm Site	09/1993
Explanation of Significant Differences is issued	12/10/1993
Onsite construction of the SVE and groundwater remediation systems begin	06/03/1994
Memorandum documenting Final Inspection, groundwater and SVE systems	03/30/1995
Preliminary Closeout Report prepared (Construction Completion)	09/29/1995
An additional 8 wells are connected to the SVE system to enhance the recovery of soil vapor from the subsurface	1998
First Five-Year Review is completed	07/21/1999

Event	Date
Soil borings to determine/verify attainment of soil remedial goals; installation of 3 dual-phase extraction wells and connection to SVE and groundwater systems	2000-2001
NPDES permit is renewed	11/20/2002
Work plan and design report for reductive dechlorination submitted by the PRPs	04/2004
EPA and SCDHEC approve cessation of SVE operations (soil remedial goals met) and pump-and-treat operations, and approve work plans for Supplemental Remedy, in-situ reductive dechlorination)	09/2004
Second Five-Year Review report completed	09/30/2004
First through fourth aquifer injections conducted: In-situ reductive dechlorination treatments (injection events), each followed by post-treatment groundwater sampling events of Site Monitoring Program wells	10/2004 to 8/2006
EPA and SCDHEC approve hiatus in injection treatments through first half of 2008, to allow aquifer re-equilibration, and to be followed up with a Site-wide sampling event in Sept. 2007	06/2007
Site-wide sampling event is conducted	09/2007
Fifth injection event is conducted; injections targeted on recalcitrant wells and deliver maximum aquifer-accepted volumes of treatment solution-water	07/2008 to 08/2008
Five-Year Review initiated with kick-off Meeting of Five-Year Review team	11/25/2008
Five-Year Review site inspection conducted	01/21/2009
Post-treatment groundwater sampling event completed	02/04/2009

Section 3. Background

The Medley Farm Site occupies approximately seven acres of a 61.9-acre tract of rural land. It is located on Burnt Gin Road, about six miles south of the City of Gaffney, South Carolina (see Attachment A). Land use in the Site vicinity is primarily agricultural and light residential.

A. Physical Characteristics

The Site is located in an area of rolling hills with elevations ranging from 570 to 680 feet above mean sea level. The Site lies within the Kings Mountain Belt of the Piedmont Physiographic Province. Bedrock in the Kings Mountain Belt consists of a sequence of interbedded, metamorphosed and deformed volcanic and sedimentary rocks. These metavolcanic and metasedimentary units strike northeast and dip moderately to steeply to the southeast.

Residual soil at the Site is absent or occurs as a thin layer overlying the saprolite. This soil layer ranges in thickness from zero to 11 feet and typically consists of clayey silt with varying amounts of fine sand, clay, mica flakes, and quartz gravel.

The saprolite is relatively thick across the Site, ranging from 50 to 70 feet thick near the former disposal areas to 7 to 28 feet along Jones Creek at the eastern boundary of the property. The saprolite consists predominantly of silt with varying amounts of fine to coarse sand and clays. The underlying bedrock consists primarily of granitic gneiss.

Groundwater at the Site occurs in the saprolite, in the zone of highly fractured and weathered bedrock zone (identified as the transition zone), and in moderately fractured bedrock underlying the Site. A controlling factor on the direction of VOC migration in the subsurface is the presence of a normal fault located southeast and downgradient of the recovery wells. The existence of the fault was recognized in the early phase of the Site's remedial design (RD) in 1993, and was based on geologic field mapping, geologic study of trenches across the apparent fault line, contours indicated on top-of-bedrock maps created from continuous rock-core drilling at Site boreholes, and observations of in-situ rock outcrops on Jones Creek. The fault strikes N50E and dips 70 degrees to the northwest.

The fault is a major reason for the elongation of the impacted groundwater plume to the northeast of the former disposal areas (see figure in Attachment A). The fault, and the related joints and fractures aligned parallel to it, serve to block southeastward flow of groundwater into Jones Creek, instead fostering a northeastward flow direction. Depth to groundwater at the Site ranges from 56 to 68 feet in the former disposal area, decreasing to six to eight feet adjacent to Jones Creek. The saprolite, transition zone, and shallow bedrock are hydraulically interconnected; therefore, these three units are considered a single aquifer.

All groundwater in South Carolina is classified as Class GB Waters (South Carolina Regulation 61-68). This designation means that all groundwater potentially meeting the definition of underground sources of drinking water must meet the quality standards set forth in the State Primary Drinking Water Regulations (R.61-58.5).

B. Land and Resource Use

The Site and the land around it are predominantly woods, farm fields and pasture. Land uses in the vicinity are mainly agricultural (farms and cattle) and light residential. Land uses, and the rural character of the surrounding area, have changed very little since the time of the ROD (1991).

Drinking water in the area is supplied by an area water authority, the Spartanburg Joint Water District (SJWD), via water lines that run along Burnt Gin Road, Fortenberry Road to the west, and Roundtree Road to the south and east. However, according to SCDHEC there are a few residences within ½-mile of the site that continue to rely on private water wells. The water authority obtains its water from nearby rivers.

C. History of Contamination

From approximately 1973 to 1976, several area textile, paint, and chemical manufacturing firms paid to dispose of their industrial wastes on the Medley property. The Site was first documented in 1981 when a firm disposing of wastes at the Site complied with the disposal notification requirements of CERCLA, reporting its use of the Medley Farm Site to EPA.

D. Initial Response

In May 1983, in response to a local citizen who witnessed the disposal of barrels on the Medley property, SCDHEC took samples at the Site. SCDHEC notified EPA of the presence of half-buried drums, many of which were leaking. That same month, EPA also investigated and sampled wastes, soil, and water at the Site.

EPA performed an emergency removal operation in June and July 1983. During this operation, EPA removed a total of 5,383 fifty-five-gallon drums and fifteen-gallon pails of waste, 2,132 cubic yards of refuse and contaminated soil, and 70,000 gallons of water and sludge from six small waste lagoons on the Site. The lagoon areas were then backfilled and graded. Testing of the solid and liquid waste materials removed from the property indicated that the primary chemicals of concern were VOCs. The Medley Farm Site was proposed for addition to the National Priorities List (NPL) in June 1986. The Site was placed on the NPL in March 1989.

SCDHEC and EPA conducted several investigative studies on the Medley property from 1983 to 1984. These studies included the sampling of private wells in the Site vicinity, a geological study, more extensive groundwater sampling, and a preliminary investigation of Site hydrogeology. During this same period, EPA compliance staff also initiated investigations to identify individuals and firms responsible for the waste disposal activities. Over the following two and a half years, EPA negotiated with several of the potentially responsible parties (PRPs) to investigate contamination at the Site.

In January 1988, five PRPs signed an Administrative Order on Consent with EPA, under which they agreed to conduct a Remedial Investigation/Feasibility Study (RI/FS) for the Medley Farm Site. The PRPs hired Sirrine Environmental Consultants to develop the RI/FS work plans and to perform the work outlined in these plans. The RI/FS began in late 1988 and was completed in early 1991. The RI/FS findings determined that the soil was contaminated with VOCs in three primary areas. It was also determined that the groundwater was contaminated with VOCs.

E. Basis for Taking Action

The RI/FS demonstrated that hazardous substances were present in soil and groundwater at the Site. Contaminants of concern (COCs) for which remediation goals (RGs) were established were as follows:

Groundwater

Acetone	1,1-Dichloroethene
Benzene	1,2-Dichloroethene
2-Butanone	Methylene Chloride
Chloromethane	Tetrachloroethylene
Chloroform	Trichloroethylene
1,1-Dichloroethane	1,1,1-Trichloroethane
1,2-Dichloroethane	1,1,2-Trichloroethane

Soil

Acetone	1,1,2-Trichloroethane
1,1-Dichloroethane	Trichloroethylene
1,2-Dichloroethane	Tetrachloroethylene
1,1-Dichloroethene	Chloroform
1,2-Dichloroethene (total)	Methylene Chloride
1,1,1-Trichloroethane	

As a result of the RI/FS results and a Baseline Risk Assessment, EPA determined that remediation of surface soil and groundwater would be required for the protection of human health and the environment. In the Baseline Risk Assessment, excess human health risks were found to be present in an assumed future-use scenario in which groundwater was used as a drinking water source. Risk was not determined to exist for the current-use scenario. Site soils were found to pose no unacceptable risks under either current-use or future-use scenarios.

Section 4. Remedial Actions

A. Remedy Selection

On May 29, 1991, EPA issued a Record of Decision (ROD) that selected the following remedy:

Groundwater: Construction and operation of a groundwater pump-and-treat system:

- Extraction of contaminated groundwater;
- On-site treatment of extracted groundwater via air stripping, with the need for controlling air stripper emissions to be evaluated in the remedial design;
- Off-site discharge of treated groundwater to Jones Creek via a National Pollution Discharge Elimination System (NPDES) permit; and
- Continued analytical monitoring of groundwater and surface water.

Soil: Construction and operation of a Soil Vapor Extraction (SVE) system:

- Installation of a network of air extraction wells in the unsaturated zone;
- Construction of a pump and manifold system that applies a vacuum on the air extraction wells to remove the contaminants from the soil; and
- Use of an in-line vapor-phase carbon absorption system to trap and absorb the soil vapor, prior to its release to the atmosphere.

The selected remedy established RGs for contaminants in Site groundwater based upon drinking water standards and on risk-based determinations from the risk assessment. For Site soil, the RGs were based on preventing leaching of contaminants to groundwater from the soils. The goals of the selected remedy (Remedial Action Objectives RAOs)) were to eliminate the principal threat posed to human health and the environment; prevent further migration of contaminants from soil to the groundwater; and remediate the affected aquifer to drinking water standards, thereby restoring its potential beneficial use as a drinking water source.

The remedy was modified in December 1993 by an Explanation of Significant Difference (ESD) issued by EPA Region IV. The ESD removed the requirement to treat SVE system emissions prior to discharge. This decision was based on air dispersion modeling. Modeling of groundwater system air emissions also indicated that anticipated emission levels were well below those which could require a permit. Results from monitoring of both systems during startup operations validated the modeling and the decision to issue the ESD.

B. Remedy Implementation

During the latter half of 1991 EPA and the PRPs negotiated a Consent Decree (CD) for design and implementation of the Site remedy (RD/RA). The CD was entered by the U.S. Department of Justice on March 27, 1992. The CD was assigned Civil Action Number 6:92-0153-20. The Settling Parties to the agreement included the following:

1. ABCO Industries, Ltd.
2. BASF Corporation
3. Colonial Heights Packaging, Inc.
4. Ethox Chemicals, Inc.
5. Evode-Tanner Industries, Inc.
6. Milliken & Company

7. National Starch and Chemical Corporation
8. Specialty Industrial Products, Inc.

In 1992 the PRPs selected RMT, Inc. of Greenville SC as their RD/RA Contractor; RMT has served in this capacity since that time. EPA approved the remedial design for cleanup of the Medley Farm Site in September 1993. The groundwater pump-and-treat system, and for soil the SVE system, operated from January of 1995 through late 2004. Although the two systems are no longer in operation, in order to better describe the overall remedy that has been implemented they are briefly described here.

The groundwater pump-and-treat system design included 11 extraction (pumping) wells and associated pipelines to direct the extracted groundwater to a central air-stripping unit. The system was a pressurized, "jet pump" system which draws water into the pumping wells via suction-based "venturi" intakes; no electric pumps were used and there were no "moving parts" inside the wells. A low-profile air-stripping unit removed the VOCs from groundwater. After treatment, the water was discharged to Jones Creek under NPDES Permit No. S00046469. The permit has been maintained since 2004. The SVE system design included an array of 9 vapor extraction wells piped to a central vacuum apparatus, to remove VOCs from three main areas of soil contamination (designated "Area 1," "Area 2" and "Area 3"). An additional eight vapor monitoring wells were installed around the three areas to monitor system effectiveness.

Onsite construction of the SVE and groundwater remediation systems began in June 1994. The majority of the construction work was completed by early December 1994. During the period December 1994 - early February 1995, punch list items from the Pre-final (December 9, 1994) and Final (January 19, 1995) inspections were corrected, and both systems were started. The corrections of inspection deficiencies and the results from both systems' "shakedown" operations were documented in the September 29, 1995 Preliminary Closeout Report.

In 1998, as an optimization measure and to enhance the recovery of soil vapors from the subsurface, the SVE system was augmented by the connection of the eight soil vapor monitoring wells to the vacuum extraction system. Borings conducted completed in 1999 in accordance with the Site's PSVP showed the soil cleanup targets in Areas 1 and 2 had been achieved. Consequently, SVE operations were terminated in these areas in June 2000. In October 2000, one additional SVE well and three dual phase (DP) wells (combination vapor- and groundwater-recovery wells), were installed to further enhance removal of VOCs from the subsurface. This augmented SVE system operated continuously through late 2004.

The groundwater treatment and SVE systems operated continuously between 1995 and 2004. As documented in the first (1999) Five-Year Review, concentrations of all of the Site groundwater contaminants decreased substantially during the groundwater extraction system's first four years of operation after 1995. In 1999, in response to decreasing recovery from the SVE system, the PRPs' contractor collected soil and groundwater samples from seven soil borings completed in the three soil treatment areas. Results from these PSVP borings demonstrated that the soil

cleanup goals had been achieved in two of the three defined soil treatment areas (Area 1, Area 2). Also, in August 1999, a limited soil investigation was performed in Area 2 to evaluate the nature of a sludge-like layer of material found during the soil-boring work. The sludge-like material was determined to not be of concern. Consequently SVE operations were terminated in Areas 1 and 2 in June 2000. However, groundwater sampling in the remaining area subject to SVE treatment, Area 3, found contamination at levels that exceeded those in any of the groundwater recovery wells.

To address the contamination, three DP recovery wells were installed in October 2000 in Area 3, to enhance the capture of both soil vapor and groundwater for treatment. The installation of these wells was part of a technical maximization program. Other measures implemented included alternate pumping and pulse purging. In 2001 a 120-foot bedrock monitoring well (designated MW-3D) was installed to better characterize the VOC concentration remaining in the groundwater in this area.

Continued SVE and groundwater systems operations over the next four years generated an increased yield of VOC contaminant mass removed from the aquifer and Site soils. As of September 2004, the groundwater recovery and treatment system had captured and treated more than 100 million gallons of groundwater and removed approximately 243 pounds of VOCs, and more than 2,250 pounds of VOCs had been removed by the SVE system. At that time, however, based on declining performance from both the groundwater treatment and SVE systems, EPA and SCDHEC approved cessation of groundwater pump-and-treat operations. For the soil component (SVE), confirmatory sampling had shown that cleanup goals were met. Concurrently, EPA and SCDHEC approved the PRPs' work plans for a Supplemental Remedial Action (RA) for groundwater, which utilizes an enhanced reductive dechlorination (insitu biodegradation) treatment process. The second (2004) Five-Year Review was completed just before approval of the work plans for the Supplemental RA.

The Supplemental RA is a "technical maximization" or optimization measure intended to accelerate remedy completion, by more effectively treating the remaining areas of groundwater which still contain contaminants above the groundwater standards. "Technical maximization measures" are generally described in Section 11 (The Selected Remedy) of the 1991 ROD.

As described in the 2004 Supplemental RA work plan, Site wells and the Site monitoring program are used to evaluate the effectiveness of the Supplemental RA activities, in comparison to the greatly-reduced effectiveness of the pump-and-treat system observed in 2004. Groundwater injection events are performed, in which nutrient (lactate) solutions are mixed onsite and placed into select groundwater wells. Based on well contaminant concentrations, formation hydraulic conductivity, experience with flowrates that can be accepted at each well, and other factors, the solutions are mixed using clean well water (verified by sampling) to which the nutrient is added, and pumped into the wells being treated. The use of site groundwater to mix the solutions, made necessary by the Site's remote location, required that an Underground Injection Control (UIC) Permit be secured (2005) and complied with in

conducting injection events as part of the Supplemental RA. After each injection, there is a variable period of time allowed for groundwater equilibrium to be restored, during which field measurements may be made, followed by a sampling event to determine the effects and influence of the treatment. Section 5 below provides additional information on Supplemental RA progress since the 2004 Five-Year Review.

C. Operation & Maintenance

Because the SVE and groundwater pump-and-treat systems are no longer operating at the Site, operations and maintenance (O&M) activities that were required for their operations, such as pressure testing of system air and water lines, preventative maintenance of blower motors, and so on, are no longer performed. As required by EPA and SCDHEC approval of the Supplemental RA Work Plan in 2004, however, the PRPs contractor has maintained both systems in a "mothballed" condition in the event either is needed to implement an additional phase of operation, should the need arise. Additionally, the monitoring and pumping wells are checked on and maintained regularly for use in the onsite activities. The NPDES permit governing discharge to Jones Creek has been maintained for use if necessary, and the reporting required for it continues. In 2007 EPA and SCDHEC approved removal of the internal well components of the two multi-level wells (annotated "MLW" on the figures in Attachments A and E), a measure requested by the PRPs as a means to improve operational capabilities for injecting larger volumes of treatment solutions.

Excluding the report-writing and project management necessary to conduct the supplemental RA, the "operations" that comprise the ongoing supplemental RA consist of conducting the groundwater injection events and the groundwater sampling which follow them. As mentioned above, injection of the treatment solutions requires preparing mixtures of the nutrient components with water, which is obtained from clean wells onsite. The UIC permit (State of SC UIC Permit No. 763) has also been maintained as necessary to govern the injection activities.

Cost information for supplemental RA activities since 2004 was provided to EPA in April 2009 by the Chairperson for the PRPs' Steering Committee. The figures provided are approximations and should not be regarded as detailed cost accounting. Total costs between 2004 and 2008 were approximately $1.5 million, and break down into the following four components (given as percentages of the total cost):

- Field activities (groundwater injection, monitoring work) 52%
- Data analysis, report prep, and administrative (non-legal) 37%
- Site maintenance, including utilities 6%
- EPA oversight costs 5%

Section 5. Progress Since the Last Five-Year Review

The second Five-Year Review in 2004 found one main issue which needed to be addressed to assure remedy protectiveness, which was the need to proceed with implementation of the

Supplemental RA (enhanced reductive dechlorination) as described above (Section 4.B.). Work plans for the Supplemental RA were approved later in 2004 and groundwater treatment actions have been in progress since that time. There were also six minor issues noted during the Site inspection:

- Unlabeled drums at the storage shed, located just northwest of the treatment building;
- Three SVE-system wells had no identification markings;
- At the treatment plant, the vault for the A-System was not covered;
- At the treatment plant, the B-System valve handle was cracked and the vault was not covered;
- Recent (2004) timber-cutting operations (by the Site owner's family, Mr. Medley, and approved by EPA) conducted on a portion of the Site appeared to have affected the wetlands north of SW-202; tire tread marks were visible through the creek bed within the logged area; and
- Due to an inaccurate map scale within the Work Plan for the Supplemental RA, five groundwater wells and one SVE well could not be located at the time of the 2004 Site inspection.

As stated in that (2004) Second Five-Year Review report, among these items only the valve handle damage could potentially have affected remedy protectiveness. In any event, all of these issues were corrected by the PRP's contractor before the date specified in the Second Five-Year Review (December 31, 2004). The fifth item refers to a logging operation in early 2004 on the Medley property but away from the Site infrastructure, which was initiated by the Medley family and coordinated with the PRP Steering Committee, EPA, and SCDHEC. During the Site inspection conducted for the Five-Year Review, tire tracks, ruts and ground damage were observed by inspection attendees. Site access procedures were verified, and there has been no recurrence of such vehicular damage. Remaining effects from logging have faded rapidly as the logged land has quickly grown back with brush and trees.

The protectiveness statement given in the last (2004) Five-Year Review was the following: "The remedy at the Medley Farm Site is expected to be protective upon completion, and in the interim, exposure pathways that could result in unacceptable risks are being controlled." This statement remains true and correct at this time.

Supplemental RA activities as planned and approved in 2004 have continued up through the time of this Five-Year Review. Between October 2004 and August 2006, four injection treatment events were conducted. Groundwater results following the latter injection showed that groundwater concentrations were further reduced and that only eight wells still had contaminants at levels above the groundwater standards. The two 2006 treatments were largely focused on the remaining recalcitrant wells. In early 2007, EPA and SCDHEC approved suspension of further injections for a period of time to allow the aquifer to re-equilibrate. A site-wide groundwater sampling event was then conducted in September 2007.

The 2007 Annual Progress Review Report was provided to EPA and SCDHEC in February 2008. The report focused mainly on the results from the September 2007 sampling event and potential options for the injection/treatment strategy going forward. In June 2008 EPA and SCDHEC completed their review of the report, finding that there have been continued reductions in the remaining groundwater contaminant mass in most site wells, although there were specific wells and areas where no reductions, or smaller reductions, were achieved. The review letter approved a general strategy for targeted injections at recalcitrant wells with subsequent monitoring and sampling after the injection event, as has been performed so far. The fifth injection treatment event was completed in July-August 2008. This action focused on "recalcitrant" wells from the last two injection treatment events and successfully placed larger volumes of treatment solution into the treated wells, which was intended to enlarge the radius of effective treatment around each well. The associated site-wide groundwater monitoring event was conducted in late January-early February 2009. The site-wide monitoring included surface water (Jones Creek). These analytical results are currently under review by EPA and SCDHEC.

Section 6. Five-Year Review Process

A. Administrative Components

EPA initiated the third Five-Year Review in November 2008 with the establishment of a Five-Year Review Team for the Medley Farm Drum Dump Site. The Kickoff Meeting was held at EPA Region 4 on November 18, 2008. Team members included the RPM, RPM's supervisor, and assigned regional Superfund staff to include a Hydrogeologist, Risk Assessor, Site Attorney, and CIC. The SCDHEC project manager was unable to attend by telephone conference but was briefed by the RPM immediately afterwards on the plans and schedule. The schedule established at that time (November 2008) set out a target date for publishing the newspaper public notice in January 2009. The remaining components were originally scheduled to be completed before June 30, 2009.

B. Community Involvement

Activities involving the community were initiated with an advertisement provided to the local newspaper stating that a Five-Year Review was to be conducted. This notice was posted in the Gaffney Ledger on January 26, 2009. A copy of the public notice is provided in Item 1 of Attachment B of this report. Also included are copies of two newspaper articles concerning the Five-Year Review and the Site groundwater remedy, which appeared in early February 2009 in the Gaffney Ledger (Item 2 Attachment B).

As part of the Site inspections conducted on January 21 and February 26 of 2009, the RPM and CIC toured the surrounding area partly to check for obvious land-use issues or large-scale development that might be of concern to neighbors living near the Site. None were observed and as noted above, the character of the land (rural, light population) and land uses seen, have changed little since the time of the ROD in 1991.

During the February 2009 Site visit, the RPM and CIC met with both the current Site owner, and a neighbor who lives across Burnt Gin Road from the Site and is attempting to purchase the Site property. The property sale was in dispute, and was at one time on a County court schedule. During the meetings discussions centered on the dispute, but each resident was asked about whether they knew of any concerns on the part of their neighbors or anyone they knew in the nearby community. Neither resident knew of any such concerns.

The CIC assigned to the Site made numerous telephone calls and queries to neighbors along Burnt Gin Road, and to Cherokee County officials. Very little feedback in the form of discussions in returned calls was received. A sample copy of the interview form prepared to document such feedback is provided as Item 3 in Attachment B. After the January 21 Site inspection the RPM visited the Site repository location, at the Gaffney Branch of the Cherokee County Library, located on East Rutledge Avenue in Gaffney. The main reference librarian was familiar with the repository materials. She indicated to the RPM that only "rarely" were the materials examined by members of the public, to her knowledge. To date there have been no comments received from the public concerning the Five-Year Review. Overall the response is consistent with other indications to the RPM that the Site is not a large concern to area residents.

Within thirty (30) calendar days of the report finalization, a notice will be published in the Gaffney Ledger announcing that the Five-Year Review report for the Medley Farm Drum Dump Superfund site is complete, and that the results of the review and the report are available to the public at the Cherokee County Public Library, 300 East Rutledge Avenue, Gaffney, SC 29340 (phone (864) 487-2711). This report will also be placed in the Administrative file at both the EPA Region 4 and SCDHEC offices.

C. Document Review

This Five-Year Review included a review of relevant documents including primarily PRP Contractor annual progress reports to EPA and SCDHEC, EPA and SCDHEC comments and responses to those reports, technical memoranda, other correspondence, the 2004 Work Plan for the supplemental remedy, and additional groundwater and surface water monitoring data provided to EPA and SCDHEC informally (E-mail). In addition to these documents which are mainly post-2004, key documents such as the ROD and the Performance Standards Verification Plan (1993) were reviewed. An EPA Risk Assessor reviewed the Baseline Risk Assessment and the exposure assumptions, toxicity data, and risk calculations developed in it (see Section 7.C. below). The cleanup levels and remedial action objectives (RAOs) from the ROD were also reviewed. Attachment C provides a list of all documents reviewed, excluding the risk-specific references reviewed for Question 7.B. Those documents, which are specific to the risk and toxicology review, are provided in the reference listing in the EPA Risk Assessor's report in Attachment F.

D. Data Review

Groundwater data and trends were reviewed by the assigned EPA Site hydrogeologist ("Groundwater Data Evaluation," Item 1 in Attachment D). In addition to data generated since 2004, sample results back to 2000 were evaluated to provide a longer period for comparison. Item 2 in Attachment D provides the tabulated results from groundwater sampling since 2004, while Item 3 provides a summary of total chlorinated ethenes since 2000, which was used for statistical and other analyses. "Total chlorinated ethenes" refers to trichloroethene, tetrachlorethene, and their breakdown products, primarily the dichloroethene isomers and vinyl chloride.

During the past five years the Site COCs have continued to exceed their RGs at certain well locations. The COCs which have exceeded their RGs (times exceeded and number of results) include the following:

Chloroform (10 of 439 results reported)
1,2-Dichloroethane (23 of 439 results)
1,1-Dichloroethene (45 of 439 results)
Cis-1,2-Dichloroethene (14 of 442 results)
Methylene chloride (1 of 439 results)
Tetrachloroethene (170 of 442 results)
1,1,2-Trichloroethane (41 of 439 results)
Trichloroethene (206 of 442 results)
Vinyl chloride (40 of 249 results)

The data review concludes that, since 2004, continued reductions in the groundwater contaminant concentrations and remaining contaminant mass have been achieved, and that the strategy employed is working. It also concludes it is a reasonable strategy going forward, and continued reductions of COC levels are likely. The review includes significant quantitative and qualitative review and discussion of the treatment injections and results to date, which will be used by the PRPs' contractor in planning continued work.

As an output from the statistical analysis, the data trends which illustrate the reductions achieved were presented in the form of boxplots for each of the four data sets analyzed: Sept. 2004, Feb. 2006, Sept. 2007, and Jan. 2009. This graphic appears on page 29 of the data review (Item 1) in Attachment D. As shown there, based on the COC detections, the injection treatments (indicated as red "down" arrows) resulted in a progressive decrease in the COC mean and median concentrations, as well as the range of 25^{th}- and 75^{th}-percentile concentrations.

In earlier reviews of the 2006 and 2007 annual RA progress reports, EPA's hydrogeologist employed a similar average-detections method to compare recent COC levels to those present in 2004. Looking at the summary data (Item 3 in Attachment D) by that measure, the February 2006 data indicated that first three injection treatments pushed the average (mean) COC concentrations down by some 78% compared to their 2004 levels. Following the approved 2006-2007 hiatus in treatments, however, some degree of "rebound" was evident in the

September 2007 data, in which the decrease from 2004 levels was only 12%. For the most recent data (January 2009), as the results are essentially the same.

However, it is important to note the qualitative conclusions drawn in the 2009 data review. These indicate that the enhanced reductive dechlorination processes used in the treatments are active and robust; among other indications this can be seen in the production of dechlorination daughter compounds. Dechlorination is a one-way non-reversible process that destroys the COCs by chemically changing them into other compounds, and eventually into non-toxic compounds, thus rebound does not mean the chemical reaction failed or was reversed. The data review notes that in addition to representing reaction inefficiencies in specific areas, some of rebound represents the movement of untreated contaminated groundwater from areas upgradient of the injection wells, into the treatment zone. This means a portion of the rebound is simply "new" untreated groundwater moving to where it can be treated by further injections. Since the actual groundwater COC contaminant mass that was present in 2004 is unknown, the 2004 data represent only an estimate of it, and some inaccuracy is to be expected. Overall, the assessment concludes that continued insitu enhanced dechlorination is a reasonable strategy for achieving continued progress toward the Site remediation goals (RGs). It also notes that such rebound effects are common to this type of groundwater treatment.

The most recent groundwater data were reported to EPA and SCDHEC in May 2009, and were presented graphically on Site maps. These are provided Attachment D (Item 4), and show the concentration isocontours for the main three remaining COCs, plus vinyl chloride, a by-product of reductive dechlorination. Wells used in creating the maps are those in the Site groundwater monitoring program, which was last revised in 2006. No changes to the program are judged necessary at this time. (Concerning the figures, although their construction is technically correct, EPA is not asserting that the depiction of the separate plume areas shown on the figures is necessarily correct, or is the only or best way to illustrate the positions of the COCs in groundwater. The figures are used here only as a means to illustrate generally the groundwater situation.)

E. Site Inspection

Two Site inspections were conducted as part of the Five-Year Review, on January 21 and February 26, 2009. The inspection of February 26 was intended mainly to support the community involvement effort, and is described in Section 6.B. above. The discussion which follows concerns the January Site inspection.

The RPM conducted a site visit and walk-through at the Medley Farm Site on January 21, 2009. Attendees were as follows:

Name	Role	Affiliation
Ralph Howard	EPA Remedial Project Manager	US EPA Region 4

Greg Cassidy	SCDHEC Project Manager	SCDHEC
Chuck Williams	SCDHEC Hydrogeologist	SCDHEC
Steve Webb	Project Manager	RMT, Inc. (PRP Consultant)
Caitlin Current	Project Hydrogeologist	RMT, Inc.
Lisa Clark	Staff Hydrogeologist	RMT, Inc.

A memorandum detailing the inspection is provided in Attachment E. Webb and Howard led the group on a walking tour and inspection of the accessible portions of the 67-acre property, focusing mainly on the infrastructure present in the areas where remediation has been performed. These areas lie along the site entrance road and along Recovery Well Lines A and B, on the main cleared field area (the three soil vapor extraction (SVE) treatment areas), the water treatment building, and the discharge point and flow-measuring weir located downhill of the treatment building on Jones Creek. No significant problems, shortcomings or issues were noted during the inspection.

The infrastructure inspected includes forty (40) wells and piezometers usable in site groundwater treatments and monitoring, of which thirty (30) are currently used in the site monitoring program. A set of photographs, mostly taken during this inspection plus a few useful ones taken in 2005, are provided as Attachment 3 to the Site inspection memorandum in Attachment E. A Site Inspection Checklist was completed; it is provided as Attachment 1 to the memorandum.

On January 22, 2009, the day after the Site inspection, the RPM visited the information repository used for all Superfund activities to date, which is the Cherokee County Main Library located at 300 E. Rutledge Street, in Gaffney. Materials available there were plentiful but are dated, and lacking in recent reports or information. At a minimum, material should be provided to the repository that explains to the public how to get more recent information from EPA via the Internet, and how to contact EPA via the Internet and E-mail for the most up-to-date information. This shortcoming needs to be addressed and will be carried as an "issue" to be addressed, but which does not affect protectiveness.

One issue for this Five-Year Review was identified as a result of reviewing operations and maintenance information as outlined in the "Site Inspection Checklist" provided in the guidance for five year reviews. Recent quality assurance initiatives at EPA Region 4, which came to the attention of the RPM in late 2008, also independently led to this finding. When the remedial actions being performed at a Superfund site are modified significantly, there is a requirement for preparing an updated Quality Assurance Project Plan (QAPP). At the time of startup of the pump-and-treat and SVE systems (1995) an approved QAPP was in place for remedial operations. Because site operations have been significantly different since the start of the Supplemental RA, a revised and updated QAPP is needed to document the quality assurance activities that are being and have been performed. The reports received from the PRP contractor demonstrate that some and possibly all of the necessary QA procedures are being done; however, a revised and updated plan is needed to fully capture and document the QA requirements and the work being done to meet them. This finding will be carried into the

Five-Year Review findings as an issue to be addressed in order to assure remedy

protectiveness. However, based upon ongoing review of the supplemental RA activities and results, no evidence of any QA problem has come to light.

F. Interviews

Interviews concerning site remedial action work were held with the PRP contractor's project manager, and with the SCDHEC project manager. These are attached to the site inspection checklist provided in Attachment E (section 6.E. above). No significant or noteworthy shortcomings were found. Concerning operational issues, the PRPs' contractor project manager commented that the modifications to the pumping system wells approved by EPA and SCDHEC in 2007 (removal of well internal components) had allowed for significantly greater volumes of treatment solutions to be injected into wells, which might lead to larger zones of effective treatment in the aquifer.

Section 7. Technical Assessment

A. Question A: Is the remedy functioning as intended by the decision documents?

The review of documents, ARARs, and the results of the site inspection indicate that the remedy is functioning as intended by the ROD. As noted in Section 6.D., the EPA Region 4 hydrogeologist assigned to the Site recently completed a lengthy technical review in support of this Five-Year Review (Attachment D). It concluded that continued reductions in the groundwater contaminant concentrations and remaining contaminant mass have been achieved, and that the strategy employed is reasonable to continue to employ against the remaining COCs in the aquifer.

Review of the ongoing remedy during 2008-09, and again for this Five-Year Review, has resulted in the identification of a requirement for institutional controls (ICs) to be employed as a remedy component at the Site. The remedy chosen in the 1991 ROD did not include ICs. However, the State of South Carolina has since the 1980s vigorously enforced water well permitting requirements that effectively blocked the realistic possibility of water supply wells being installed on the Medley property. The regulations, together with the continued presence of Medley family members living at the one house located at the Site (close to Burnt Gin Road), and the presence of a locked gate to the Site entrance road, have served as an informal "check" on any potential improper well installations. However, comparison of Site circumstances with EPA's recently-strengthened requirements for ICs indicates that ICs are needed for the Site property. Because the limits of the groundwater COC plume are well-defined and lie within Site boundaries, ICs do not appear to be necessary on any surrounding properties at present.

During 2008 and 2009, because of the property ownership dispute mentioned earlier (section 6.B.) and concerns about Site infrastructure being protected, the Site PRPs chose to negotiate a

set of deed restrictions with Site owner Mr. Sam Medley. The restrictions have been added to the property deed as of June 2009. EPA was not a party to this action, but at the PRPs request the assigned EPA Assistant Regional Counsel and the RPM reviewed and commented on the language prior to its being finalized. A remaining task is for EPA to modify the remedy to incorporate the requirement for ICs, and to determine if the Agency's IC requirements are fulfilled by the current ICs in force. This requirement will be carried as an issue for this Five-Year Review.

The role of the Supplemental RA currently in progress within the overall Site remedy in the ROD brings forward another issue recognized during the conduct of this Five-Year Review. The Supplemental RA was approved as a "technical maximization measure" as recognized in the ROD. Current remedial actions are at the limit of what was foreseen in the ROD in 1991, for groundwater remediation. A remedy modification is needed to allow for use of the enhanced insitu dechlorination treatments, as used in the supplemental RA. It is anticipated that either an ESD or a ROD Amendment will be necessary to capture this modification, as well to incorporate the IC requirements discussed above.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

A review of these remedy criteria was performed by an EPA Risk Assessor (Attachment F, Item 1). Overall, the review recommended that no changes to the soil or groundwater RGs be made. It also concluded that the exposure pathways have not changed since the ROD was signed in 1991. As documented in the Site inspection, there do not appear to be any land or resource use changes at or near the Site.

Although the RGs for soil have been met, the review considered the risk criteria applied to the soil pathway. Since the time of the remedy, there have been no changes in the cancer slope factor for 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, methylene chloride, bis-2-ethylhexylphthalate and toxaphene. Six of the COCs, including 2-dichloropropane, styrene, tetrachloroethene, trichloroethene, vinyl chloride, and Polychlorinated Biphenyls (PCBs) have new or revised toxicity values. A recalculation of risk was performed comparing the original toxicity values from the original Baseline Risk Assessment and the revised toxicity values currently recommended by EPA. For carcinogenic risks, the new or revised slope factors increased or decreased the overall risk value for each receptor. For the most sensitive receptor, the adult/child resident, the total soil ingestion/dermal risk decreased from 2.0E-5 to 5.0E-6, which is within EPA's acceptable risk range of 1.0E-4 to 1.0E-6. The cleanup levels identified in the ROD were recalculated based on the new or revised toxicity values. The resultant finding was that they are still within EPA's risk range. Attachment F provides the details of the revised toxicity values and the new, recalculated risk levels resulting from the changes.

On the groundwater exposure pathway, there have been no changes in the cancer slope factor for four of the 12 groundwater COCs: chloromethane, 1,2-dichloroethane, methylene chloride, and

1,1,2-trichloroethane. However, five of the remaining eight COCs have new or revised toxicity values. These COCs are benzene, 1,1-dichloroethane, 1,1-dichloroethene, tetrachloroethene and trichloroethene. A recalculation of risks was performed comparing the original toxicity values from the original Baseline Risk Assessment and the revised toxicity values currently recommended by EPA. For carcinogenic risks, the new or revised slope factors increased or decreased the overall risk value for each receptor. For the most sensitive receptor, the adult/child resident, the total groundwater ingestion risk decreased from 2.0E-2 to 9.0E-4, which still exceeds EPA's acceptable risk range of 1.0E-4 to 1.0E-6. The cleanup levels identified in the ROD were recalculated based on the new or revised toxicity values. The finding from this was that they remain within EPA's risk range. Attachment F provides the details of the revised toxicity values and the new, recalculated risk levels resulting from the changes.

Since the time of the 1991 ROD there have been new human health-based standards assigned to some of the Site COCs. Table 2 below provides a summary of those changes.

Table 2: Changes in Chemical-Specific Groundwater Standards

COCs	1991[a] Max Conc. Detected (µg/L)	1991[a] Rem Levels from ROD (ug/L)	1991[a] Rem Exceeded (Y/N)	2004[b] Second 5-Year Review MCLs	2004[b] Second 5-Year Review MCLs Exceeded (Y/N)	2009[c] 5-Year Review MCLs	2009[c] 5-Year Review MCLs Exceeded (Y/N)	2009[d] Regional Screening Level (µg/L)	2009[d] Health Regional Screening Level? (Y/N)
Acetone	1.8E+01	3.5E+02	no	N/A	N/A	N/A	N/A	2.2E+03	no
Benzene*	1.1E+01	5.0E+00	YES	5.0E+00	YES	5.0E+00	YES	N/A	-
2-Butanone	1.3E+01	2.0E+03	no	N/A	no	N/A	N/A	7.1E+02	no
Chloromethane	2.6E+01	6.3E+01	no	1.0E+02	no	N/A	N/A	1.8E+00	YES
Chloroform*	1.0E+01	1.0E+02	no	1.0E+02	no	N/A	N/A	N/A	-
1,1-dichloroethane	1.2E+02	3.5E+02	no	N/A	no	N/A	N/A	2.4E+00	YES
1,2-dichloroethane	2.9E+02	5.0E+00	YES	5.0E+00	YES	5.0E+00	YES	N/A	-
1,2-dichloroethene (mixed)	N/A	7.0E+00	N/A	N/A	no	N/A	N/A	3.3E+01	-
1,2-dichloroethene* (cis)	2.2E+03	7.0E+01	YES	7.0E+01	YES	7.0E+01	YES	N/A	-
1,2-dichloroethene* (trans)	3.1E+01	1.0E+02	no	1.0E+02	no	1.0E+02	no	N/A	-
methylene chloride*	1.1E+02	5.0E+00	YES	5.0E+00	YES	5.0E+00	YES	N/A	-
tetrachloroethene*	2.0E+02	5.0E+00	YES	5.0E+00	YES	5.0E+00	YES	N/A	-
1,1,1-trichloroethane*	3.4E+03	2.0E+02	YES	2.0E+02	YES	2.0E+02	YES	N/A	-
1,1.2-trichloroethane*	1.8E+01	5.0E+00	YES	5.0E+00	YES	5.0E+00	YES	N/A	-
trichloroethene	7.2E+02	5.0E+00	YES	5.0E+00	YES	5.0E+00	YES	N/A	-

[a]1991 Remediation Levels from the 1991 ROD. "Remediation Levels" are the same as Remedial Goals, RGs.
[b]2004 Second 5-Year Review MCLs based on 2003 MCLs. The term "2003 MCLs" distinguishes these values from earlier-promulgated versions of the MCLs.
[c]2009 5-Year Review MCLs based on 2003 MCLs.

[d]2009 Regional Screening Levels for tapwater corresponds to a 10E-6 risk level for carcinogens or a Hazard Quotient (HQ) of 1 for non-carcinogens (EPA, 2008).
*MCLs were used as Remediation Levels in the 1991 ROD.

A review of the remedy ARARs other than those specifically related to risk was completed by the RPM. None of those requirements has been changed or revised in a manner that would impact the remedy. Site conditions have not changed in any ways that would cause the ARARs to impact the Site remedy. A table of these ARARs as cited in the ROD is provided as Item 2 in Attachment F.

Finally, the possibility of vapor intrusion as an exposure pathway has gained increased attention recently at groundwater-contamination sites which have chlorinated organics as the COCs. Vapor intrusion is the migration of the vapor form of certain VOCs into homes or other buildings such that exposure to residents or workers is possible by way of breathing. At the time of the remedy (1991) this pathway was unknown. At the Medley Farm Site, the closest monitoring well to an occupied structure does have a concentration of tetrachloroethylene recorded in January 2009 of 403 ppb, with lesser concentrations of three other COCs. However, the well is 300 feet distant from the house, and the house is located uphill and upgradient of both the well and the groundwater plume. The preliminary judgement from Region 4's technical services staff is that vapor intrusion is unlikely to be an issue based on current information; however, this needs to be more definitively determined. The requirement for this determination will be carried forward as an issue for this Five-Year Review.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that calls into question the protectiveness of the remedy.

Technical Assessment Summary:

According to the data reviewed, the site inspection, and the interviews, the remedy is functioning as intended by the ROD. There have been no changes in the physical conditions of the Site that would affect the protectiveness of the remedy. From the technical assessment, three issues, concerning vapor intrusion, remedy modification to address ICs, and remedy modification to allow use of additional remedial technologies, require follow-up to assure remedy protectiveness. There is no other information that calls into question the protectiveness of the remedy.

Section 8. Issues

Five (5) issues were identified as a result of the Technical Assessment and the other Five-Year Review activities for the Medley Farm Site. Table 3 below identifies the issues in terms of their current or potential future effect on protectiveness of the Site remedy.

Table 3: Issues

Issue	Currently Affects Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
A revised and updated QA project plan (QAPP) is needed to document the quality assurance activities that are being performed for the RA.	N	Y
Site remedy needs to be modified in order to incorporate the requirement for institutional controls (ICs).	N	Y
Site remedy needs to be modified to select an appropriate remedial technology, considering enhanced insitu biodegradation and other feasible technologies, to continue the Site remedial action.	N	Y
A determination is required as to whether the vapor intrusion pathway is a concern at the Site.	N	Y
Materials at information repository are out of date and need to be augmented with more information for the public about the RA, and about how to access more information from EPA.	N	N

Section 9. Recommendations and Follow-up Actions

Table 4 below highlights the recommended follow-up actions, assigned responsibilities, and milestone dates for addressing the issues identified in this Five-Year Review. Issues 2, 3 and 4 were identified from the technical assessment, while issues 1 and 5 were found as a result of other Five-Year Review activities. The most significant actions will be those addressing issues 2 and 3, modification of the Site remedy to address ICs and potential remedial technologies, which will guide the ongoing cleanup activities in the near future. Issues numbered 1, 4 and 5 are expected to be resolved without any particular difficulties.

Table 4: Recommendations and Follow-up Actions

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
1. A revised and updated QAPP needed	Current QAPP will be revised and updated to document QA activities performed in the continuing RA.	PRPs	State, EPA	2/28/10	N	Y
2. Need to modify Site remedy to incorporate requirements for ICs.	Conduct remedy modification through either an ESD or ROD Amendment process.	EPA	EPA, State	05/31/10	N	Y
3. Need to modify Site remedy to select an appropriate remedial technology for continuing Site RA.	Conduct remedy modification through either an ESD or ROD Amendment process.	EPA	EPA, State	05/31/10	N	Y
4. Determine whether vapor intrusion pathway is of concern at the Site.	Conduct technical evaluation as necessary.	EPA/State	EPA, State	5/31/10	N	Y
ITEM BELOW REQUIRES FOLLOW-UP BUT DOES NOT AFFECT PROTECTIVENESS.						

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
5. Materials at information repository out of date, need to be augmented with more information about the RA and about how to access information.	As part of the remedy modification requirements, provide documents concerning the RA, as well as directions for access of information via the Internet, to the repository.	EPA	EPA	5/31/10	N	N

Section 10. Protectiveness Statement

The remedy at the Medley Farm currently protects human healthy and the environment because the soil cleanup goals were attained in 2004, the groundwater remediation is continuing to decrease the concentrations of COCs, and no one is drinking water from the contaminated groundwater plume. However, in order for the remedy to be protective in the long term, the following actions need to be taken: modify the decision document to incorporate the requirement for Institutional Controls, modify the decision document to modify the remedial action for groundwater, conduct a vapor intrusion assessment, and revise and update the Quality Assurance Project Plan.

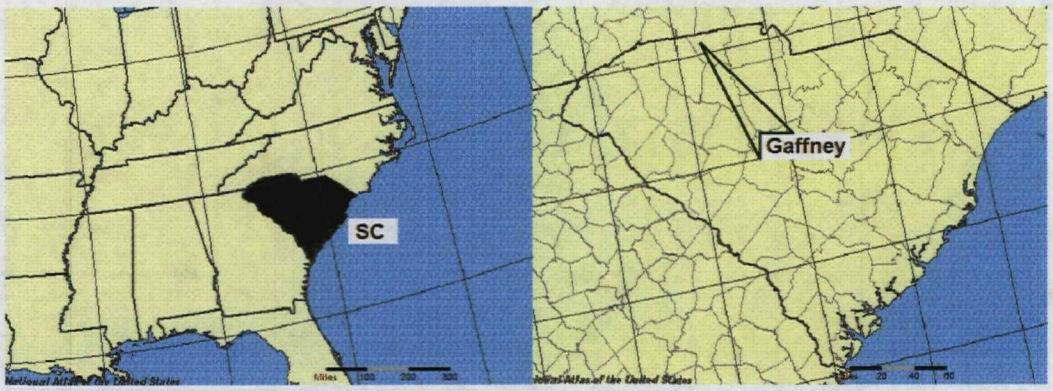
Section 11. Next Review

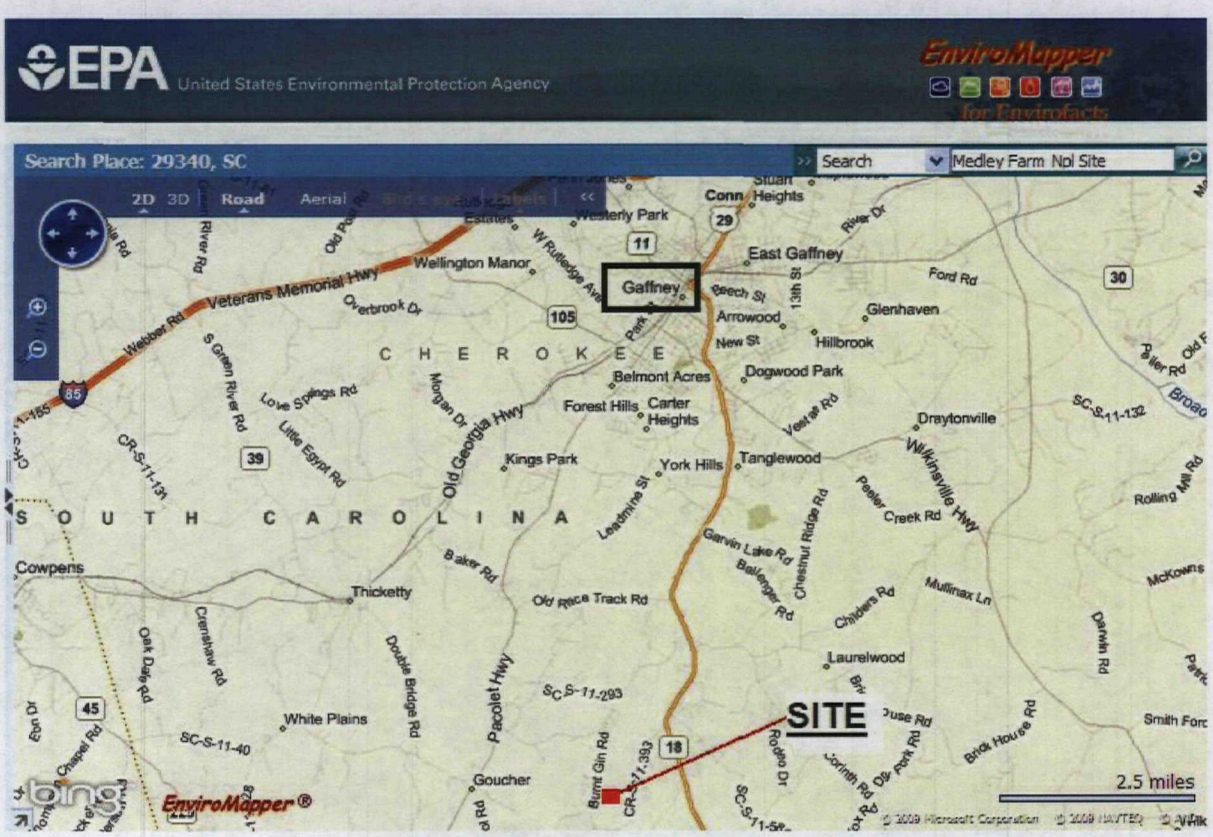
Since ongoing remedial action has not achieved the cleanup standards set forth in the ROD, EPA guidance mandates that another Five-Year Review will be conducted to evaluate the Site's status. Therefore, it will be necessary to re-evaluate the effectiveness of the remedy on or before five years from the date of signature of this Five-Year Review Report.

ATTACHMENT A

Site Location and Layout Maps

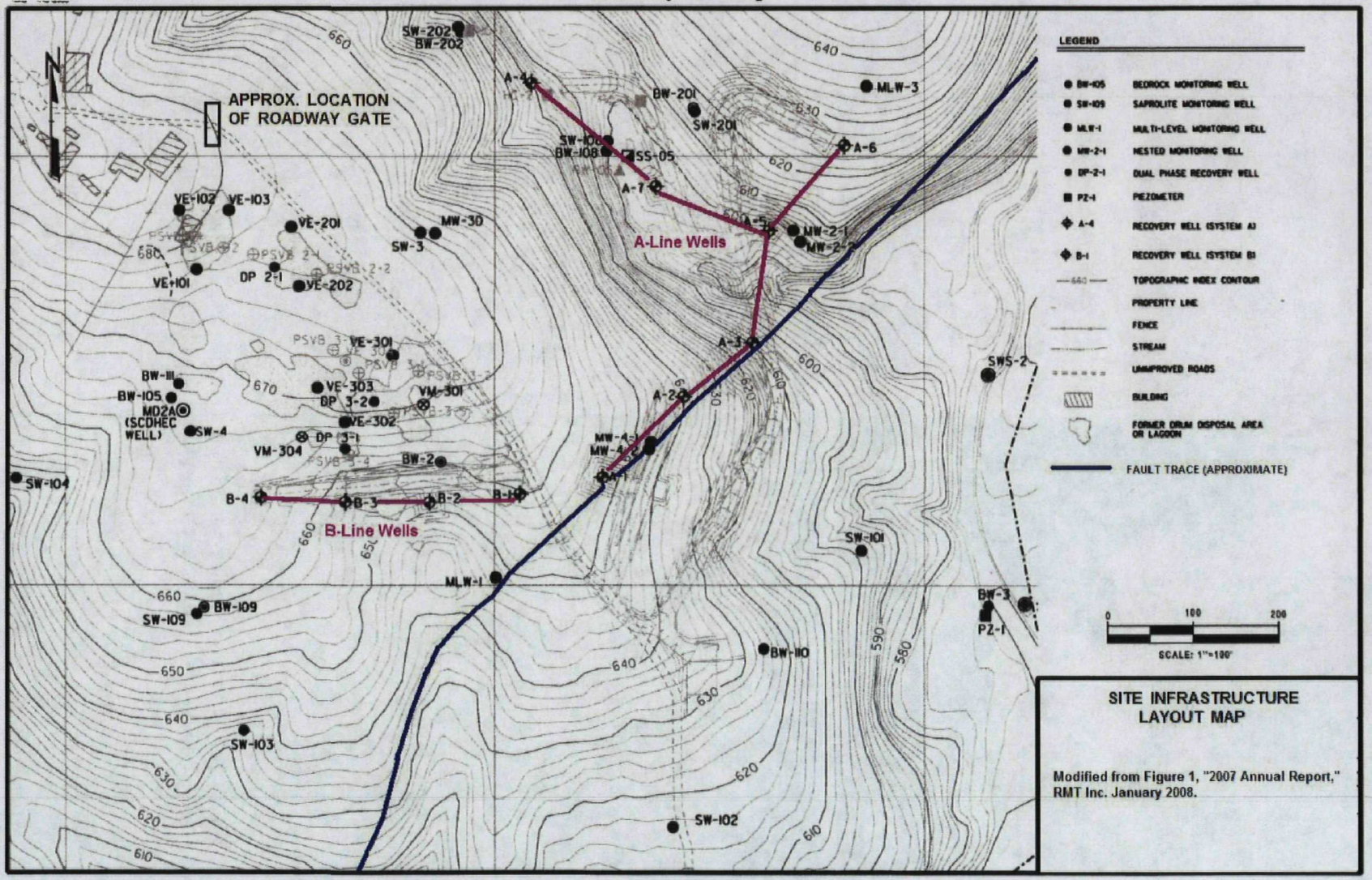
Site Location Map





SITE LOCATION. The Medley Farm Drum Dump Site is located approximately six miles south of Gaffney, SC on Burnt Gin Road just off SC Highway 18.

Site Layout Map



ATTACHMENT B

Community Involvement Records

Item 1
Public Notice Advertisement

THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Announces the

3rd Five-Year Review

For the

Medley Farm Drum Dump Site

The U. S. Environmental Protection Agency (EPA) is conducting the 3rd Five-Year Review of the remedy for the cleanup up activities taken at the Medley Farm Drum Dump Site located in Gaffney (Cherokee County), South Carolina. The purpose of this review is to evaluate the implementation and performance of the remedy in order to determine if the remedy is protective of human health and the environment. When completed, a copy of the review report will be placed in the Information Repository files located at the Cherokee County Library, 300 East Rudledge Avenue, Gaffney, SC 29340, (864) 487-2711, and the EPA Record Center, 11th Floor, 61 Forsyth Street, S.W. Atlanta, GA 30303. EPA will also conduct a number of interviews by telephone or in person with nearby businesses, residents, local officials, state officials, and others to obtain their opinion on the cleanup process.

The community can contribute during this review by providing comments or questions. The scheduled date of completion for the five-year review is September 30, 2009. If you would like to speak with us about this Site, please contact Linda Starks, EPA Public Affairs Specialist at (404) 562-8487. If you have any technical questions, please contact Ralph Howard, EPA Remedial Project Manager at (404) 562-8829.

Item 2
Newspaper Articles, *Gaffney Ledger*

Poll

Who will you vote for in the special election for SC House District 30?

EPA conducting another review of Medley Farm superfund site

By TIM GULLA Ledger Staff Writer
tim@gaffneyledger.com

The U.S. Environmental Protection Agency is embarking on another review of the Medley Farm superfund site in Gaffney.

Officially designated as the agency's 3rd five-year review, the process will evaluate the implementation and performance of the cleanup work conducted at the site to determine if the work done there is "protective of human health and the environment," according to an EPA release.

The latest study should be completed by September, according to the EPA. During the process, the EPA says if will be conducting interviews with nearby businesses, residents and local and state officials.

The Medley Farm site is a seven-acre parcel south of Gaffney that was being used as a chemical dumping ground. In 1983, the EPA conducted an emergency cleanup during which it removed more than 5,300 55-gallon chemical drums and 70,000 gallons of contaminated water containing a number of hazardous industrial chemicals from benzene to

tricholobenzene.

The site subsequently was added to the EPA's "National List of Priorities" for cleanup in 1989.

According to a report from the South Carolina Department of Health and the Agency for Toxic Substances and Disease Registry, environmental contamination appeared to be confined to the site and no data indicated the public is being exposed to levels of contamination that would be expected to cause adverse health effects.

According to EPA records that fill a shelf at the Cherokee County Library, nine companies that had chemicals at the site entered into an agreement with the EPA in 1987 to pay $560,000 in reimbursement for the 1983 cleanup costs.

The owner of the property, Ralph Medley, told the EPA in a handwritten response to the EPA's demands for information in 1983 the drums had been on the property for 10 to 12 years and that he never was given any company names, numbers or addresses for the firms depositing the drums on his property.

To one specific question about the drums, he replied, "No comment, except I did not know they were harmful. If I had, they would not be here."

During a 1991 hearing, an EPA representative said ongoing cleanup and monitoring costs would range from $1.8 million to $2.4 million and that the process could take 10 to 30 years.

Poll

Who will you vote for in the special election for SC House District 30?

Groundwater contamination still present at Medley site

By TIM GULLA Ledger Staff Writer
tim@gaffneyledger.com

It's not a perfect success story yet for the U.S. Environmental Protection Agency, but an official said the Medley Farms superfund site has come a long way from the environmental mess discovered in 1983.

The EPA is in the midst of its third 5-year review of the superfund site south of Gaffney, a review necessitated by the fact that test results show some toxic chemicals above allowable limits continue to be present in the groundwater.

While he can't predict when the EPA's involvement at the Gaffney site will end, EPA remedial project man- ager Ralph Howard said ongoing cleanup efforts are getting the site closer to the EPA's goals.

In 1983, more than 5,300 chemical drums were removed from the Medley Farm site during an emergency cleanup. The site was subsequently added to the EPA's national list of priorities in 1989. After several years of research, two systems were constructed in 1995 to clean the soil and groundwater of the contaminants.

By 2004, the soil cleanup efforts had met EPA targets and the EPA and state health officials agreed to the cessation of a solid vapor extraction system at the site. Howard said that system acted like a giant vacuum cleaner to rid the soil of chemical vapors.

Groundwater cleanup continues to this day, though.

Of the 25 test wells on the property, eight of the wells still show some levels of the chemicals dumped on the site, albeit at much lower levels.

The EPA's goal is to get the water clean enough to meet drinking water standards. Typical in such efforts, the amount of chemicals removed by the initial filter-type system slowed over time and a new type of clean-up effort using microorganisms to consume the chemicals began in 2004.

The cleanup efforts are being paid for by the companies whose chemicals were found on the site, Howard said. "They've done everything the EPA has asked," he said.

When the process began it was believed it could take as many as 30 years to clean up the site. It's been about 13 years since the process began.

"We really don't know (how close we are to finishing)," Howard said. "We've got cleanup goals and for the time being we still intend to make them meet those cleanup goals."

If it's ultimately determined that cleanup efforts can't reach the drinking water goals, Howard said the EPA could close the books and place restrictions on the water use. But, he said, "Our mission is not to settle for that."

Item 3
Sample Interview Form

Item 3
Sample Interview Form

[redacted]

Site Name: **Medley Farms** EPA ID No.: 0473

Interviewer Name: Sherryl Carbonaro Affiliation: U.S. EPA

Subject's Name: [redacted] Affiliation: Resident

Address: [redacted] Burnt Gin Rd., Gaffney, SC 29340

Date: 4/28/2009

Type of Interview: Phone **(left message with reason for call, no response)**

1. Are you aware of the former environmental issues at the Medley Farms site and what cleanup activities have taken place to date?

2. What is your overall impression of the project?

3. What effect has this site had on your business (if applicable) or the surrounding community, if any?

4. Have there been any problems with unusual or unexpected activity at the site, such as emergency response, vandalism, or trespassing?

5. Should EPA do more to keep involved parties and surrounding neighbors informed of activities at the site? By what methods?

6. Do you have any comments, suggestions, or recommendations regarding the project?

ATTACHMENT C
List of Documents Reviewed

Date of Document	Document
May 1991	*Record of Decision, Medley Farm Drum Dump Site.* US EPA, Region 4, Atlanta, GA.
August 1993	*Performance Standards Verification Plan.* RMT, Inc., Greenville SC.
June 2004	*Revised Work Plan and Design Report for Reductive Dechlorination.* RMT, Inc., Greenville SC. (Revised; Final version dated August 2004)
February 2006	*2005 Remedial Action Annual Report.* RMT, Inc., Greenville SC.
August 2006	Letter, RMT, Inc., Greenville SC, Subject: Performance Monitoring Plan, Medley Farm Site, Gaffney, South Carolina. RMT, Inc., Greenville SC.
October 2006	Letter, RMT, Inc., Greenville SC, Subject: Responses to USEPA Comments on 2006 Performance Monitoring Plan, Medley Farm Site, Gaffney, South Carolina. RMT, Inc., Greenville SC.
March 2007	*2006 Remedial Action Annual Report.* RMT, Inc., Greenville SC.
October 2007	*Technical Memorandum: Site-Wide Sampling Event at the Medley Farm NPL Site, Gaffney, South Carolina.* RMT, Inc., Greenville SC.
February 2008	*2007 Remedial Action Annual Report.* RMT, Inc., Greenville SC.
May 2008	*Responses to Agency Comments on 2007 Remedial Action Report.* RMT, Inc., Greenville SC.
May 2009	*Technical Memorandum: Status Report of 2008 Medley Farm NPL Site Nutrient Injection Event and Performance Monitoring Results.* RMT, Inc., Greenville SC.
2005-2008	U.S. EPA "Review and Comments" Letters, concerning the above-listed reports and technical memoranda. Dates of the letters are April 14, 2005; June 13, 2007; and June 25, 2008.

ATTACHMENT D

Groundwater Data Review (2009) Documents

Item 1

Groundwater Data Evaluation to Support the Third Five-Year Review, Medley Farm NPL Site Gaffney, South Carolina

Region 4 Superfund Division
Technical Services Section
August 2009

Introduction and Purpose of This Report

The Medley Farm NPL Site is located in a rural area outside of Gaffney, South Carolina. From 1973 until sometime in 1976, the site was used as a disposal area for industrial wastes. Based on site monitoring data, the disposed materials of concern were primarily chlorinated solvents.

Figure 1 shows the core of the Medley Farm Site, highlighting wells that are considered in this report. The wells that are evaluated in this report are either completed in the bedrock or in the lower part of the bedrock-saprolite transition zone or zone of partially weathered rock. Shallower monitoring wells ("SW" wells) either had limited sampling results relative to deeper samples and/or yielded samples that were either uncontaminated or marginally contaminated by the Site, relative to the deeper groundwater.

In late 2004, the groundwater extraction and treatment remedial action at the Medley Farm Site was suspended and enhanced reductive dechlorination was attempted to determine if a change in the remedial strategy was warranted. Since that time, there have been several injections of an organic carbon source into the groundwater in an attempt to produce conditions more favorable for reductive dechlorination. This report was prepared to evaluate the progress of the reductive dechlorination efforts at the Medley Farm Site and to recommend further steps to advance the groundwater remedial action to reach the performance objectives for groundwater cleanup.

Contaminants of Concern

By the time of the completion of the second Five-Year Review in July 2004, the groundwater contaminants of concern at the Medley Farm Site were essentially chlorinated solvents. Specifically, chlorinated solvents that exceeded their respective drinking-water maximum contaminant levels (MCLs) or non-zero maximum contaminant level goals (MCLGs) during the last five years include (for all monitoring data, including some wells not shown on Figure 1) chloroform (exceeded in 10 of 439 results reported); 1,2-dichloroethane (exceeded in 23 of 439 results reported); 1,1-dichloroethene (exceeded in 45 of 439 results reported); cis 1,2-dichloroethene (exceeded in 14 of 442 results reported); methylene chloride (exceeded in 1 of 439 results reported); tetrachloroethene (exceeded in 170 of 442 results reported); 1,1,2-trichloroethane (exceeded in 41 of 439 results reported); trichloroethene (exceeded in 206 of 442 results reported); and vinyl chloride (exceeded in 40 of 249 results reported).

Several of these compounds are known or potential degradation products of more highly chlorinated solvents. Tetrachloroethene can degrade to trichloroethene, which in turn can

degrade to cis 1,2-dichloroethene, trans 1,2-dichloroethene, and 1,1-dichloroethene; these contaminants can in turn degrade to vinyl chloride (Wiedemeier et al, 1998; Figure 2.2). 1,1,2-trichloroethane can degrade to form vinyl chloride and 1,2-dichloroethane (Chen et al, 1996; Figure 7). However, at least some of these potential degradation products may have also been present in materials dumped at the Site.

As can be seen from the "detect" statistics presented above, the groundwater contamination present at the Site is primarily chlorinated ethene solvent contamination. For the most recently available data from January/February 2009, contaminants exceeding their performance standards were basically tetrachloroethene (PCE), trichloroethene (TCE) and their degradation products, principally cis 1,2-dichloroethene (cis 1,2-DCE) and vinyl chloride. For this reason, this report focuses on these contaminants in an evaluation of the progress of the groundwater remedial action.

Data Used in this Analysis

Including some data obtained before the Five-Year Review, monitoring results from 20 different monitoring events or monitoring periods were considered in this review. As shown in Table 1 below, the number of groundwater samples collected during each of these monitoring periods has varied from 10 to 49. A larger number of wells have been monitored since immediately before and during the period of lactate injection that commenced in the fall of 2004.

Date	Number of Samples	Date	Number of Samples
Aug 2000	10	Mar 2003	11
Nov-Dec 2000	34	Jun 2003	11
Mar 2001	11	Sep 2004	34
May 2001	10	Dec 2004	21
Aug 2001	10	Feb 2005	20
Dec 2001	31	Sep 2005	21
Mar 2002	12	Feb-Mar 2006	37
Jun 2002	12	Nov 2006	21
Aug 2002	12	Sep 2007	49
Dec 2002	29	Jan 2009	43

Remedial Action Background

Groundwater remedial action at the Medley Farm Superfund Site began in 1995 with the operation of a pump and treat system of 11 recovery wells located at varying distances downgradient of the identified waste disposal areas. After several years of operation, the recovery of contaminated groundwater was enhanced with the operation of three dual-phase wells designed to recover both contaminated groundwater and soil vapor.

At the time of the last Five Year Review (July, 2004), the pump and treat system was in operation. Reportedly, the system had removed over 100 million gallons of groundwater

containing 243 pounds of volatile organic compounds (South Carolina Department of Health and Environmental Control (DHEC), 2004). The soil vapor extraction component of the remedy had reportedly removed over 2,234 pounds of volatile organic compounds, mostly from a part of the Site known as Area 3. Figure 2 below shows the locations of the recovery wells, dual-phase recovery wells, and contaminant source areas, with Area 3 highlighted.

Attachment D to the Second Five-Year Review summarizes how the recovery of volatile organic compounds changed over the period from 1995 through 2002. Predictably, the rate of contaminant mass removal decreased dramatically as the recovery well system operated through successive years. Of some interest is the fact that recovery of contaminants from the B series of wells decreased far more dramatically than the recovery of contaminants from the A series of wells. The B series of wells are located in close proximity to the contaminant source areas, whereas the A series wells are located in areas more distant from the source areas. The more dramatic change in concentration over time for the B series wells may be a result of the soil vapor extraction system arresting further contaminant transfer to the groundwater, along with the limited distance of flow paths between the upgradient extent of contamination and the B series wells, resulting in a shorter time, relative to the A wells, of the occurrence of the initial phase of contaminant removal via extraction wells. See O'Steen, 1998, for more discussion of the initial phase of contaminant removal via a pump and treat system.

In late 2004, injection of a carbon source (sodium lactate solution) designed to enhance reductive dechlorination of chlorinated organic compounds began at the Medley Farm site. This remedial strategy was attempted in order to enhance removal of contaminants from the groundwater. EPA, DHEC, and the PRPs agreed that the pump and treat groundwater remedial action appeared to be at or approaching a point at which further reductions of contaminant concentrations or contaminant mass would be inefficient. From late 2004 until the present, there have been five lactate injection events of varying intensities.

Conceptually, the cessation of groundwater removal via pumping and the periodic introduction of solutions into the recovery wells raised the water levels at the recovery wells and changed the patterns of groundwater flow across most or all of the area of groundwater contamination. The injection of the treatment solution also modified the aqueous geochemistry of the subsurface to a condition more favorable for reductive dechlorination of the primary contaminants of concern at the Site. The progress of the groundwater remedial action during the lactate injection period is the focus of this report.

Data Evaluation Procedures

Data evaluation was done using several different procedures that are described below. Two approaches were primarily used for data presentation. One approach was plotting data in a graphical format. Various types of plots were made using Microsoft Excel. In the second approach, spatial and temporal contaminant concentration relationships were plotted using the Surfer® contouring and mapping program. Some figures were produced that combined both data

presentation techniques; for example, by showing small-scale x-y graphs for different sample locations superimposed on a site base map. Some of the data were also subjected to exploratory statistical analysis, in order to be able to more fully understand and represent temporal concentration changes. For this exploratory statistical analysis the Minitab® statistical package was used.

Total Chlorinated Ethene Trends

Plots of total chlorinated ethenes (sum of PCE, TCE, cis 1,2-DCE and vinyl chloride) were developed to provide an overview of groundwater contamination over time. Plots were constructed for various time periods, both before and after the initiation of lactate injections. The expected change in total chlorinated ethenes is one of decreasing total concentrations over time, with possibly a more pronounced rate of decrease observed after initiation of the injection of lactate solutions.

Parent-Daughter Molar Ratio Analysis

The molar concentrations of chlorinated ethene parent compounds (PCE and TCE) relative to the molar concentrations of daughter compounds (cis 1,2-DCE and vinyl chloride) were determined for key monitoring wells from the period preceding the first lactate injection until the most recently available data from January-February 2009. Parent-daughter molar ratios were evaluated. Molar concentrations are preferred to concentrations in standard reported units (e.g. mg/L) because the stoichiometric calculations require that molar values, not standardized concentrations, be used to determine how parent ethene compounds are converted to daughter products. For example, consider the reductive dechlorination of trichloroethene reacting with toluene. The balanced equation is

$$18C_2HCl_3 + 14H_2O + C_6H_5CH_3 \Rightarrow 18C_2H_2Cl_2 + 7CO_2 + 18H^+ + 18Cl^-,$$

where 18 moles of trichloroethene produce 18 moles of 1,2-dichloroethene in the reaction. The molecular weight of trichloroethene is 131.4 (131.4 g/mol) whereas the molecular weight of 1,2-dichloroethene is 96.94 (96.94 g/mol). Thus, if the reaction was expressed in terms of micromoles (μmol), and then the micromoles (expressed in terms of μmol/L) were converted to μg/L, approximately 2,365 μg/L of trichloroethene yields 1745 μg/L of cis 1,2-DCE in the balanced reaction.

In order to better show how parent to daughter ratios have changed over time, ratios were converted to log values. This conversion allowed for same-scale spatial plots of ratios over the entire monitoring period when the raw molar ratio values ranged over more than four orders of magnitude. Parent to daughter temporal trends were also plotted on x-y graphs, which were then superimposed on a site base map figure to show how ratios have changed at key monitoring wells.

Concentration Rebound Plots

These plots show the concentrations of each of the four chlorinated ethenes over time, plotted along with lactate injection volumes over time. Results were plotted for each of the injection points. These plots were created to show how concentrations in the immediate vicinity of each injection point have responded to attempts to change the subsurface geochemistry to enhance reductive dechlorination.

Dissolved Oxygen Plots and Graph and pH Evaluation

Field measurements of dissolved oxygen made during the period of lactate injection were evaluated. The EPA guidance document *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water* (EPA, 1998), establishes three ranges of dissolved oxygen concentrations associated with three different levels of geochemical favorability for reductive dechlorination of chlorinated ethenes. According to Table 2.3 in that document, if the dissolved oxygen concentration in the most contaminated zone is less than 0.5 mg/L, anaerobic biodegradation is tolerated. Dissolved oxygen suppresses the reductive pathway at higher concentrations. Section 2.3.2.2 of the *Technical Protocol* states "Anaerobic bacteria generally cannot function at dissolved oxygen concentrations greater than about 0.5 mg/L." Table 2.3 indicates that at a dissolved oxygen concentration of greater than 5 mg/L in the most contaminated zone, anaerobic biodegradation does not occur. Dissolved oxygen was therefore evaluated as an indicator of changing geochemical conditions more favorable for reductive dechlorination. Additionally, the groundwater pH is a factor in the environmental suitability for dechlorinating bacteria. Therefore, the pH over time was also considered in this analysis.

Data Evaluation Results

Total Chlorinated Ethene Trends

Figure 3 shows total chlorinated ethene concentrations for three pre-injection and three post-injection monitoring events. Data points used to produce the contour maps are shown for each sample period. Note that the wells that were sampled were not identical for each sampling event. The difference in sample locations has some influence on the contouring of concentrations because of the kriging geostatistical analysis used. However, Figure 3 does reasonably show the generalized trends in total chlorinated ethenes.

The first sampling event from November 2000 shows the highest total chlorinated ethene concentrations were much higher for that monitoring period, relative to all subsequent monitoring periods. The February 2006 data shows the lowest concentrations, with no data point reaching the 0.2 mg/L total concentration used as the minimum plotted value on the maps. Results from the last monitoring event in January 2009 show that at DP-2-1, the concentrations have increased substantially, relative to the previous sampling event in September 2007. The September 2007 and January 2009 results suggest there has been only a minimal improvement in

the total chlorinated ethene concentrations, relative to the December 2001 and September 2004 periods prior to the first lactate injection.

While the Figure 3 plots generalize overall chlorinated ethene trends through a spatial representation, they do not readily show the chlorinated ethene trends from a statistical population sense. For this reason, a boxplot analysis was done to provide more insight into the trends in chlorinated ethene concentrations over time.

The boxplot is a convenient visual way to represent sample population statistics. Figure 4 is a series of boxplots showing the statistical distribution of total chlorinated ethene results from the six monitoring periods shown on Figure 3, as well as illustrating the fundamentals of a boxplot. Figure 4 does not show any Minitab-identified statistical outliers, in order to improve the graphical representation of the median, mean, the confidence interval on the median, and the 75th percentile values. These are the more critical statistical measures for comparative analysis of the six data sets and omission of potential outliers in the figure has no bearing on the statistical measures that are shown. Figure 4 also shows the periods of lactate injection, and the relative volumetric magnitude of each injection.

Figure 4 shows that following the initial three injections, the total chlorinated ethene concentration measured in the wells shown on Figure 3 for the February 2006 monitoring event was much lower than for earlier monitoring periods in terms of the mean, median, and 75th percentile value (75% of observations are less than that value). This comparison suggests that the repeated lactate injections over a period of slightly more than one year had a pronounced effect on the dissolved chlorinated ethene concentrations in the groundwater.

The September 2007 boxplot shows that some sample population statistics were closer to those for December 2001 and September 2004 than to the February 2006 statistics. However, the mean, median and 75th percentile values were all lower for September 2007 compared to any period prior to the first lactate injection. The increase in total chlorinated ethenes between February 2006 and September 2007 probably reflects the minimal additional lactate application during that period, but more importantly, indicates that some contaminant mass that was unaffected by the lactate injections had managed to migrate into the zones of active groundwater flow that are intersected by the monitoring wells and former extraction wells. The source of this contaminant mass could be contaminated groundwater recharge, inflow of contaminated groundwater from upgradient areas, or back-diffusion of contaminated groundwater from aquifer matrix or low permeability zones that were not reached by the lactate solution.

The January 2009 results suggest that the most recent lactate injection from August 2008 had a limited effect on the groundwater contamination, if evaluated in terms of total chlorinated ethene concentrations. There are a number of possible reasons for this, including a lag time between lactate injection and the concentration response, or the establishment of a generally "stable" geochemical environment by September 2007, whereby the maximum potential for geochemical optimization had already been reached. Most importantly, comparison of the total chlorinated ethene concentrations from different time periods does not consider potentially significant

changes in the proportions of the different chlorinated ethenes present. Note also that because some of the monitoring points differ between various sample events, there is some inherent error or bias to this comparative analysis. Overall, however, Figures 3 and 4 present a valid overview of the beneficial changes in groundwater quality that have occurred in response to lactate injection.

Parent-Daughter Molar Ratio Analysis

Parent-daughter molar ratios indicate how more chlorinated compounds (PCE and TCE) are changing to less chlorinated compounds (cis 1,2-DCE and vinyl chloride) in response to lactate injections. Although many figures showing the spatial distribution of parent-daughter ratios were generated, six plots (three from pre-injection sampling events and three from sampling during the injection period) were used to illustrate how the molar ratios have changed over time.

Figure 5 shows the six molar ratio plots. All results are shown on a log scale, which allows for presentation of ratios that span multiple orders of magnitude. This approach was used so that a visual comparative analysis for the pre-injection and injection period results could be done on the same page.

The November 2000, December 2001, and September 2004 results show that molar ratios are all greater than 1, indicating that PCE and TCE concentrations exceeded cis 1,2-DCE and vinyl chloride concentrations. Vinyl chloride data were not reported for either November 2000 or December 2001, which may positively bias the results. However, for the September 2004 data, all cis 1,2-DCE concentrations equaled or exceeded the vinyl chloride concentrations, and for 27 of 28 September 2004 results, vinyl chloride was not detected. Therefore, it is reasonable to conclude that the November 2000 and December 2001 representations are valid.

In contrast, data from February 2006, September 2007 and January 2009 show multiple areas where the log molar ratio is a negative value, indicating that cis 1,2-DCE+vinyl chloride exceeds PCE+TCE. Note that these negative log ratios show considerable spatial and temporal variability over much of the area of deep saprolite and bedrock groundwater contamination. The discrepancy is particularly noteworthy for the September 2007 results, where a low ratio of approximately 0.007 at DP-3-2 is observed roughly 100 feet distant from a ratio of 5.89 at BW-2. Such differences suggest the presence of spatially and/or temporally localized geochemical environments supporting or inhibiting reductive dechlorination processes. At some areas, there have been dramatic changes in the molar concentration ratios over time during the period of lactate injections. The changes are indicated on a broad scale by Figure 5.

A figure (not included) was prepared from the Figure 5 injection period data to evaluate if the total chlorinated solvent concentration was likely to be correlated with molar ratios. No relationship between the total chlorinated ethene concentration and log molar ratio was indicated for any of the three periods.

A second analysis of the lactate injection period data compared the molar concentration ratios to the proximity of a monitoring well to the approximate center of the contaminant source area (considered to be the north-central part of source area 3 as it is shown on Figure 2). No obvious relationship was seen between these variables. These results imply that other factors such as spatially variable hydraulic properties, geochemical factors such as dissolved oxygen concentration, and the presence of secondary source areas (e.g. back-diffusion from the aquifer matrix) have a more prominent role in the spatial variability in molar concentration ratios.

Figure 6 shows the log molar concentration ratios plotted for each of the injection-period sample events shown on Figure 5 and includes the log molar concentration ratios for an additional sample event from February 2005, shortly after lactate injection began. Figure 6 is a more explanatory means of presenting the temporal changes in log concentration ratios during the lactate injection period.

For the February 2005 sample event, the log concentration ratios are mostly negative values (more cis 1,2-DCE+vinyl chloride than PCE+TCE), as indicated by the mean and median log ratios. There are several points where the log ratios are about an order of magnitude or greater.

During the February 2006 event, which followed the third lactate injection by about two months, there were still several monitoring locations where the ratio of PCE+TCE to cis 1,2-DCE+vinyl chloride was about an order of magnitude or greater. This pattern suggests that the repeated lactate injections were not sufficient to overcome conditions inhibiting reductive dechlorination. For these wells, reductions in total chlorinated ethenes compared to pre-injection periods, combined with little change in molar concentration ratios between pre-injection periods and February 2006, may indicate contaminant concentration reduction mostly through dilution of groundwater by the introduced lactate solutions. A reduction in total chlorinated ethenes occurring with some relatively modest reduction in the molar concentration ratio would likely be observed for a pre-treatment condition where there was little production of daughter products because of more oxic conditions or some other factor that inhibited but did not fully suppress reductive dechlorination. Such an area would probably be more resistant to a change in the molar concentration ratio than another area where the pre-treatment molar concentration ratios were closer to a value of 1. Regardless of the persistent positive molar concentration ratios in a few locations, for February 2006, the mean and median ratios of PCE + TCE to cis 1,2-DCE + vinyl chloride were both negative values, and had decreased relative to the mean and median values for February 2005, indicating a general condition where groundwater geochemistry was becoming more conducive to reductive dechlorination.

Figure 6 results from September 2007 and January 2009 show a slightly higher average ratio of PCE+TCE to cis 1,2-DCE and vinyl chloride relative to the February 2006 values. However, the range in ratios appears to be smaller for each successive sampling event. Such a condition is consistent with a spreading of the lactate solution, or spreading of the altered geochemical conditions resulting from the lactate injection. The presence of several areas of positive molar concentration ratios after repeated lactate injections probably reflects the inability of the geochemical modifications via lactate injection to overcome preexisting geochemical conditions

that were unfavorable for reductive dechlorination, combined with the inability of the lactate applications to overcome any addition of relatively untreated contamination from residual sources such as recharge or back-diffusion out of the aquifer matrix.

Figures 7, 8, and 9 were prepared to evaluate the relationship between the location of monitoring points, injection points, and the ratio of PCE+TCE to cis 1,2-DCE+vinyl chloride. It was hypothesized that the injection points would generally show lower ratios of PCE+TCE to cis 1,2-DCE and vinyl chloride, at least initially, as the lactate solution would be present in the highest concentration at the injection points. Figure 7 appears to show such a condition, where log ratios for all of the injection wells monitored in February 2006 were negative values, while 6 of 16 monitoring wells had positive log ratios. Figure 8 shows that for September 2007, there are still more monitoring wells than injection wells with positive log ratios; however, there does not appear to be a relationship between log ratio and well status. The September 2007 data were collected after a one-year period since the previous (and relatively small-scale) lactate injection. The January 2009 log ratios are shown on Figure 9. Figure 9 again indicates that the injection wells generally have a lower ratio of PCE+TCE to cis 1,2-DCE+vinyl chloride. This condition implies that although there is some overlap between injection well and monitoring well ratios, the ratio of PCE+TCE to cis 1,2-DCE+vinyl chloride is predictably generally lower at injection points compared to monitoring wells.

Figure 10 shows pre-injection period and lactate injection period molar ratio trends for various monitoring and injection wells at different distances relative to the contaminant source areas. Figure 10 shows that PCE+TCE to cis 1,2-DCE+vinyl chloride concentration ratios were very high and quite temporally and spatially variable in the period before lactate injection began. The results from the lactate injection period show much less spatial and temporal variability. These trends support the conclusion that lactate injection has resulted in a more widespread area where geochemical conditions are conducive to reductive dechlorination. Also, the large near-source well decreases in ratios from the treatment period, relative to the pretreatment period, are an indication of the efficiency of the lactate treatment, although the data also indicate the PCE+TCE to cis 1,2-DCE+vinyl chloride molar ratios had already decreased substantially before lactate injection began.

Concentration Rebound Analysis

An important question concerning the treatment of groundwater to enhance reductive dechlorination is whether or not such treatment creates long-lasting improvements in the geochemical environment and chlorinated solvent concentrations. Evaluation of the total chlorinated ethene trends indicated there are residual contaminant sources that have caused rebound of contaminant concentrations at some wells during the lactate injection period. To more thoroughly evaluate the long-term effectiveness of reductive dechlorination, concentration rebound plots were created. These concentration rebound plots show the dates and volumes of lactate solution injected at each well and the concentrations of PCE, TCE, cis 1,2-DCE, and vinyl chloride over time at each injection well. These data representations provide some of the

most informative measures of the efficacy of the reductive dechlorination program, and therefore, the plots are evaluated in detail.

Ideally, the introduction of lactate solution should cause the concentrations of the more chlorinated solvents to decrease, should produce transient increases in the concentrations of less chlorinated solvents, and should not be followed by increases in concentrations of the more chlorinated solvents. Deviations to this conceptual process may indicate movement of additional parent compound contaminant mass out of untreated areas (shallower ground water; low permeability zones; aquifer matrix; upgradient areas) or movement of contaminants or lactate out of upgradient treatment areas.

Figure 11 was produced to show concentration rebound plots at injection wells in closer proximity to the contaminant source areas. Figure 12 shows concentration rebound plots at injection wells more distant from the source areas. A discussion of the rebound plots for each injection well follows.

Injection Wells near Source Areas (reference Figure 11)

DP-3-1 DP-3-1 shows large drops in the concentrations of both PCE and TCE after the initial injection, with a sharp increase in the cis 1,2-DCE concentration. The second sample after the initial lactate injection showed increases in both PCE and TCE relative to results from the first post-injection monitoring event, although pre-injection concentrations were not reached. The cis 1,2-DCE concentration continued to increase, and vinyl chloride also increased. The second monitoring event after the initial lactate injection probably indicates that untreated PCE and TCE mass was being reintroduced into the active groundwater flow system more rapidly than either advective transport or continued reductive dechlorination could completely remove it, although reductive dechlorination continued to result in increasing concentrations of cis 1,2-DCE and vinyl chloride.

Later sample results showed decreases in all four compounds, with PCE and TCE becoming inconsequential after three additional, large-volume lactate injections. After the second lactate injection in June 2005, the concentrations of cis 1,2-DCE and vinyl chloride became comparable, and have remained so throughout all subsequent monitoring events. The 2009 sample from DP-3-1 showed that all four chlorinated solvents had decreased to very low concentrations. In that sample, vinyl chloride was present at the highest concentration, and slightly exceeded its primary drinking water standard (0.0029 mg/L versus a 0.002 mg/L standard). No rebound in either PCE or TCE was noted between the fourth injection in August 2006 and the subsequent groundwater sample collected more than one year later. The repeated lactate injections at this well have apparently very effectively increased reductive dechlorination and caused large decreases in contaminant concentrations.

B-4 At well B-4, the first lactate injection initially caused a large increase in the cis 1,2-DCE concentration and concomitant decreases in the concentrations of both PCE and TCE. By the time of the second sampling following lactate injection, vinyl chloride had become the contaminant with the highest concentration, and total ethene concentrations were much lower than in previous samples.

The last B-4 injection occurred in December 2005. A subsequent sampling event in early 2006 showed some increase in the concentration of cis 1,2-DCE; however, total contaminant concentrations at that time were inconsequential.

The next sampling event in September 2007 showed a dramatic increase in the vinyl chloride concentration, and some increase in both cis 1,2-DCE and TCE, relative to the previous sample event. The vinyl chloride increase is interpreted as reflective of movement of chlorinated solvents downgradient of DP-3-1, with ongoing reductive dechlorination of cis 1,2-DCE between the two wells producing a higher vinyl chloride to cis 1,2-DCE ratio at B-4, away from the DP-3-1 injection point. The increase in the TCE concentration from 2006 to 2007 was small; it may reflect a slight rebound condition, with some TCE mass entering the active groundwater flow system in the vicinity of B-4 and not being completely converted to less chlorinated compounds by the time it reached the well location.

The last sample from early 2009 showed virtually no contamination. The 2009 sample suggests that groundwater contamination in this area has been effectively treated by the lactate injections.

B-3 At well B-3, September 2004 pre-injection contamination was primarily TCE, with a lower concentration of PCE and inconsequential cis 1,2-DCE. Three lactate injections occurred before the next groundwater sample from early 2006. In that sample, PCE and TCE were nondetect, and cis 1,2-DCE and vinyl chloride were present in inconsequential concentrations.

The following sample from late 2006 showed large increases in concentrations of TCE, cis 1,2-DCE, and vinyl chloride; although the daughter products cis 1,2-DCE and vinyl chloride equaled or exceeded the TCE concentration, the rising TCE concentration indicated introduction of TCE contaminant mass, probably from some area of untreated or partially treated groundwater upgradient of the well. The subsequent B-3 sample from September 2007 showed continued notable increases in the cis 1,2-DCE and vinyl chloride concentrations, but a decrease in the TCE concentration, relative to the November 2006 sample.

Although there are several possible causes for the 2006 to September 2007 concentration trends observed at well B-3, a likely scenario is that (a) the November 2006 increase in parent compounds represented a largely untreated or partially treated volume of groundwater pushed out ahead of the bulk of the groundwater being driven

downgradient of well DP-3-1 due to the large-volume injections at that well, and (b) by September 2007, that TCE and PCE contamination was beginning to be displaced or dechlorinated, while the cis 1,2-DCE and vinyl chloride concentrations at B-3 were still increasing in response to either the arrival of more thoroughly treated groundwater from the vicinity of DP-3-1 or from reductive dechlorination caused by lactate solution introduced at B-3, which by September 2007 had more effectively altered the groundwater chemistry downgradient of DP-3-1.

The last B-3 sample from January 2009 showed that vinyl chloride concentrations had surpassed cis 1,2-DCE as the principal chlorinated ethene and that TCE and PCE were effectively removed from this area. Although long-term trends cannot be completely assessed based on the January 2009 data, it appears that lactate injection efforts, either at B-3 or upgradient of the well, have produced an environment favorable to reductive dechlorination, which has resulted in removal of the parent compounds.

B-2

At well B-2, September 2004 pre-injection contamination was primarily TCE with subordinate PCE. By early 2006 the primary chlorinated ethene contaminants at B-2 were cis 1,2-DCE and vinyl chloride, with the transition apparently caused by enhanced reductive dechlorination as a result of three injections of lactate from late 2004 until December 2005. However, the next B-2 sample from November 2006 showed a large increase in the TCE concentration, along with some increase in the PCE and cis 1,2-DCE concentration, with a decrease in the vinyl chloride. The subsequent B-2 sample from September 2007 showed an even higher concentration of TCE, some increase in both the PCE and cis 1,2-DCE concentrations, and a lower vinyl chloride concentration.

The trends in concentrations at B-2 from the second injection period sample in late 2006 through the September 2007 sample are interpreted to be indicative of a process similar to that described for the same monitoring period at B-3, although the B-2 trends are more pronounced and show both a lower and more delayed response of daughter product concentrations to upgradient injections. One possibility is that an area of particularly contaminated groundwater between well B-2 and upgradient well DP-3-1 and/or well DP-3-2 was, at the time of the initiation of lactate injection, present in a stagnation zone. A stagnation zone is caused by competitive stresses on an aquifer that create a very low hydraulic gradient, such as is observed in an area between nearby pumping wells. When pumping stopped and lactate injection began, any such stagnation zone contamination would have been mobilized, and it probably reached the vicinity of B-2 before most of the treated groundwater from upgradient injection points arrived, but after most of the lactate solution injected at B-2 had already been used up or moved downgradient.

In response to the large TCE increases at B-2, a large-volume lactate injection occurred there in August 2008. The B-2 sample from early 2009 showed a

precipitous drop in TCE, a decrease in PCE, a notable rise in vinyl chloride, and modest increase in cis 1,2-DCE at B-2, relative to the last pre-injection sample from September 2007. The concentration changes at B-2 suggest that the introduction of more lactate effectively caused dechlorination of the TCE and PCE present in the September 2007 sample. However, it is unknown the degree to which the September 2007 contamination at B-2 was removed by displacement of water from upgradient, reductive dechlorination caused by earlier, large-volume lactate injections at wells DP-3-1 and DP-3-2, or by the B-2 large volume lactate injection in August 2008. More data are needed from this well to understand if the early 2009 chlorinated ethene concentrations are representative of long-term conditions or if further changes in concentrations will occur.

B-1 After the first lactate injection at well B-1, the concentrations of PCE and TCE sharply decreased and the concentrations of vinyl chloride and especially cis 1,2-DCE increased. This dramatic change in relative concentrations of chlorinated ethenes occurred by December 2004, indicating a fast response of the groundwater geochemistry to the lactate injection.

Following the initial post-injection sample from December 2004, a sample obtained in February 2005 showed nondetect concentrations of PCE and TCE, a slightly lower concentration of cis 1,2-DCE, and a higher concentration of vinyl chloride, compared to the December 2004 sample. These results indicate conditions that favored further reductive dechlorination beyond cis 1,2-DCE at this location. Reductive dechlorination is sometimes observed to stall at cis 1,2-DCE, resulting in buildup of this daughter product without further dechlorination. One causative factor is the development of methanogenic conditions under conditions of high lactate concentrations, whereby methanogenic bacteria easily compete with *Dehalococcoides* bacteria (which will completely degrade chlorinated ethenes) for hydrogen, arresting reductive dechlorination of cis 1,2-DCE (Kean et al, 2001). Significant vinyl chloride production has been observed at many injection wells at Medley Farm, which indicates that complete reductive dechlorination to non toxic end products is at least possible.

Two subsequent B-1 samples from September 2005 and February 2006 showed inconsequential contamination by chlorinated ethenes; however, a sample collected in September 2007 showed increases in PCE, TCE, and cis 1,2-DCE, with TCE present at the highest concentration. These increases probably are related to the same cause for the more dramatic concentration increases observed at well B-2 and well B-3 beginning in late 2006. Another B-1 lactate injection occurred in August 2008, and the subsequent sample from early 2009 indicated that both cis 1,2-DCE and vinyl chloride increased over their concentrations from September 2007, while PCE and TCE decreased to concentrations below detection and less than their performance standard, respectively.

DP-3-2 At DP-3-2, pre-injection concentrations of PCE and TCE were well above their respective performance standards. The PCE and TCE decreased to concentrations below their performance standards at the time of the first injection period sample collected in February 2006. The decrease followed three large-scale injections. Surprisingly, no production of either cis 1,2-DCE or vinyl chloride was observed. There are several possible reasons for this condition, including complete reductive dechlorination or biodegradation to non-chlorinated end products or complete flushing of contamination out of the vicinity of DP-3-2 following the repeated large-volume lactate injections.

A subsequent sample from September 2007 showed a very high concentration of both cis 1,2-DCE and vinyl chloride, which would be expected given the reductive dechlorination patterns observed elsewhere and the pre-injection total chlorinated ethene concentrations reported from DP-3-2 (see Figure 3; the western "bulls eye" of contamination from November 2000 is centered on DP-3-2). An additional 8672-gallon lactate injection at DP-3-2 occurred in August 2008. The subsequent sample showed declining concentrations of both cis 1,2-DCE and vinyl chloride relative to the September 2007 results. This decrease may have been as much a result of the dilutional effects of adding more lactate solution to this well than to any in-situ biodegradation. The have been no indications of significant PCE or TCE concentration rebound at DP-3-2.

DP-2-1 DP-2-1 was monitored infrequently prior to the initial lactate injection at other points in late 2004. The first DP-2-1 lactate injection was in August 2006, following a July 2006 sampling event in which 0.16 mg/L of TCE and 0.066 mg/L of PCE were detected. A follow-up sample from November 2006 showed decreased concentrations of both TCE and PCE (although both still exceeded performance standards) with limited or no production of daughter products in response to the lactate application. A September 2007 DP-2-1 sample showed that PCE and TCE had increased over the November 2006 concentrations, indicating that the initial lactate treatment had probably been inadequate.
A second, large-volume lactate application occurred at DP-2-1 in August 2008. The DP-2-1 sample from early 2009 showed some modest increases in cis 1,2-DCE and vinyl chloride concentrations, relative to the September 2007 results, indicating a probable response of contamination to the 2008 lactate injection. However, the PCE and TCE concentrations had also increased, and more substantially, to levels exceeding or greatly exceeding concentrations seen in July 2006, before the first DP-2-1 lactate injection occurred. The cause for the PCE and TCE concentration increases is unknown, but may be related to water-level increases in the post-pumping environment, and some incompletely remediated contaminant source in the source areas near or upgradient of DP-2-1.

The 2009 DP-2-1 sample may have been collected too soon after the August 2008 lactate treatment to have observed the full response of the groundwater chemistry to

additional lactate application. However, there is probably a need for further lactate injection in this area, considering the dramatic increase in the PCE and TCE concentrations between September 2007 and early 2009.

Injection Wells More Distant from Source Areas

A-4 Pre-injection concentrations of PCE and TCE were less than their respective performance standards. Regardless of this condition, lactate injection occurred at A-4 in November 2004, June 2005, December 2005, and August 2008. The first lactate injection produced below detectable concentrations of PCE and TCE and a corresponding increase in the concentration of cis 1,2-DCE by February 2005. The cis 1,2-DCE concentration had sharply increased following the third lactate injection. However, between February 2006 and September 2007, the concentration of cis 1,2-DCE dropped, while the concentrations of PCE and TCE increased to values higher than those observed immediately before the first lactate injection and for TCE, a concentration slightly an its performance standard. The fourth lactate injection in August 2008 apparently reversed the upward concentration trend for PCE and TCE, bringing the concentration of TCE back to a value less than its drinking water standard and raising the concentration of cis 1,2-DCE and vinyl chloride. Additional lactate injection may be necessary if PCE and TCE rebound to above their performance standards, but it is possible that after the last lactate injection, PCE and TCE concentrations will remain below the MCLs and vinyl chloride will stabilize at a concentration less than its performance standard.

A-7 Pre-injection concentrations of PCE and TCE exceeded their performance standards in samples from this well. The well was not sampled between late 2004 and February 2006, after three lactate injections had occurred. The February 2006 sample contained TCE at a concentration of 0.0046 mg/L and no PCE. Subsequent samples from September 2007 and February 2009 showed continuing declines in the TCE concentration and in total chlorinated ethenes in general. Lactate treatment appears to have been effective in this general area.

A-2 Pre-injection concentrations of PCE and TECE exceeded their respective performance standards. An A-2 sample was collected in December 2004, just after the initial November 2004 lactate application at the well. The December 2004 sample showed a sharp increase in the cis 1,2-DCE concentration, a modest increase in the vinyl chloride concentration, and sharp decreases to below performance standards for PCE and TCE, demonstrating a rapid transition to a more reducing environment after the lactate application. Subsequent monitoring events initially showed concentration decreases of all chlorinated ethenes; however, a sample from November 2006, following a fourth lactate injection, showed increases to above performance standards for TCE. A September 2007 sample showed similar results as the November 2006 sample. A fifth lactate injection occurred at A-2 in August 2008. The subsequent early 2009 sample contained mostly vinyl chloride, at a concentration above its

performance standard. It is unknown if concentrations of TCE will remain below performance standards or rebound as occurred between February and November 2006.

A-3 Prior to the initial November 2004 lactate injection at A-3, concentrations of PCE and TCE exceeded their respective performance standards. A-3 was next sampled in February 2006, after three lactate injections. At that time, TCE was still the predominant chlorinated ethene present, but its concentration was less than the performance standard, and almost an order of magnitude less than its concentration in September 2004. A-3 was resampled in November 2006, after a fourth lactate injection in August 2006. The November 2006 sample contained concentrations of PCE and TCE that approximated the pre-injection concentrations, and contained cis 1,2-DCE at a concentration greater than anything previously observed.

The cause for the increased November 2006 A-3 concentrations is unclear. One possible scenario is that when lactate injections began, an area of relatively high contaminant concentrations was trapped in a stagnation zone between wells A-2 and A-3 and eventually managed to migrate to the vicinity of A-3 after pumping stopped. However, post-pumping lactate injection rates at the two wells may not support such a scenario. A September 2007 sample from A-3 contained even higher concentrations of PCE and TCE that exceeded the September 2004 pre-injection concentrations. A fifth lactate injection occurred in August 2008. The following February 2009 sample had a higher TCE concentration than the September 2007 sample, although the PCE concentration had decreased somewhat relative to the September 2007 result. Reductive dechlorination initially appeared to be effective in this area, but later sample results indicate that reductive dechlorination has been ineffective here. This condition appears to be localized, since the nearest well, A-2, shows an entirely different time versus concentration picture for chlorinated ethenes, despite having initially higher PCE and TCE concentrations than at A-3 and lower volumes of lactate solution applied (Figure 12).

A-5 Well A-5 had concentrations of both PCE and TCE above their performance standards before the initial November 2004 injection event. Contamination at A-5 showed substantial changes between the pre-injection September 2004 sample and the subsequent December 2004 sample. Both PCE and TCE concentrations decreased below their performance standards, and the cis 1,2-DCE concentration increased. Contaminant concentrations remained very low or were nondetect in samples from September 2005 and February 2006. However, despite an additional application of lactate at this well in August 2006, the concentration of both PCE and TCE climbed to above their pre-injection concentrations in a sample from September 2007. A final larger-volume lactate injection in August 2008 appears to have produced some positive response in the A-5 sample from early 2009, because vinyl chloride and cis 1,2-DCE concentrations increased from September 2007 to 2009, while PCE, and

TCE, although still both above their performance standards, decreased from September 2007 to February 2009.

The pattern at well A-5 is somewhat similar to that seen at A-3, except that for A-5, a larger data set from the 2004-2006 period attests to removal of PCE and TCE through reductive dechlorination rather than potentially through dilution or plume displacement, and at A-3, the reductive dechlorination process seems to be ineffective considering the most recent data, whereas reductive dechlorination may still be an effective process at A-5. It is probable that at both wells, the increases in PCE and TCE observed in samples following multiple lactate injections are a result of contamination in either stagnation zones between pumping wells or contamination in lower hydraulic conductivity zones not as effectively treated by lactate injection migrating into the vicinity of those wells. The stagnation zone scenario appears to be more likely the principal factor responsible for the increased concentrations of PCE and TCE at A-3 and A-5. Migration of previously slowly moving or immobilized contamination out of stagnation zones is an expected outcome of conditions where more or less continuous recovery well pumping is stopped.

A-6 Pre-injection concentrations of PCE and TCE at well A-6 exceeded their performance standards. Both PCE and TCE showed dramatic concentration decreases from September 2004 to the next sample obtained in early 2006, after three lactate applications at the well. The cis 1,2-DCE concentration increased from September 2004 to February 2006. Since that February 2006 sample, cis 1,2-DCE concentrations have continued to increase, and vinyl chloride concentrations have also notably increased, while both PCE and TCE concentrations have remained below performance standards. Lactate injection appears to have functioned very effectively at this location.

Dissolved Oxygen Plots and Graph and pH Evaluation

As noted above, the efficacy of reductive dechlorination is related to the concentration of dissolved oxygen in the groundwater. Lactate injection is intended to introduce biodegradable organic matter into the subsurface. The available dissolved oxygen should be utilized in oxidation of the organic matter, resulting in a more reducing environment that is conducive to reductive dechlorination, and enhanced growth of bacteria capable of degrading the chlorinated ethenes. The lactate application must first create the anaerobic environments capable of supporting dechlorinating bacteria, then lactate must be present in sufficient concentrations to sustain reductive dechlorination until there is sufficient depletion of the more chlorinated compounds, such as PCE and TCE. At the Medley Farm site, an oxygen scavenging compound was proposed to assist in the removal of dissolved oxygen from the aquifer (RMT, 2004). This oxygen scavenging would optimize the utilization of lactate or compounds derived from the lactate in microbially-mediated reactions with chlorinated solvents.

In order to evaluate the geochemical environmental favorability for reductive dechlorination, a series of maps was produced showing field-measured dissolved oxygen concentrations over time in bedrock or lower saprolite monitoring locations. Conceptually, the addition of lactate at the various introduction points should produce an increasingly favorable environment for reductive dechlorination. Figure 13 shows map views of the degree of favorability, based on dissolved oxygen concentrations.

There is an order of magnitude range in the points identified on Figure 13 as being locations of marginal reductive dechlorination, based on the dissolved oxygen concentration. Therefore, Figure 13 was used in conjunction with Figure 11 and Figure 12 in an attempt to understand temporal trends in the concentrations of chlorinated ethenes. Additionally, the groundwater pH influences the reductive dechlorination process. According to EPA's *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water* (EPA, 1998), a groundwater pH of less than 5 or greater than 9 is outside the optimal range for reductive dechlorination. Other studies have found that the optimal range for reductive dechlorination is a pH of between 6.8 and 7.8 (Robinson et al, 2009). Furthermore, reductive dechlorination produces hydrogen ions, depressing the pH and perhaps limiting the efficacy of reductive dechlorination by inhibiting the activity of dechlorinating microorganisms (Robinson et al, 2009). Therefore, the pH of groundwater was also evaluated to determine if there was any potential for pH control on reductive dechlorination efficacy.

Figure 13 shows the maps of the favorability of the groundwater environment for reductive dechlorination based upon field-measured dissolved oxygen and groundwater pH. These figures use the broader range of pH cited in the EPA guidance as indicators of a favorable environment for reductive dechlorination. As such, there are few samples where the pH falls outside the favorable range, and Figure 13 is largely a representation of the dissolved oxygen favorability at various locations and times. Broadly, Figure 13 shows some improvement in the favorability of the subsurface for reductive dechlorination for later periods, versus earlier periods. The first period shown from December 2004 is the monitoring event immediately following the initial lactate injection, and none of the sample points show a favorable environment for reductive dechlorination. This observation is not fully supported by the monitoring data, which show some notable declines in concentrations of PCE and TCE and notable increases in cis 1,2-DCE for samples collected shortly after the initial lactate application, indicating accelerated or initiated reductive dechlorination in response to the lactate injection. Later dissolved oxygen results do indicate a trend toward conditions more conductive to reductive dechlorination. This is not only shown broadly by Figure 13, but is also shown on Figure 14, which more informatively plots the temporal changes in dissolved oxygen concentrations over time. Figure 14 shows that for the more recent sampling events, data points that plot within the marginal to unfavorable range are generally clustered at the lower end of the range (note the median dissolved oxygen), compared to earlier results where the average dissolved oxygen was greater.

The dissolved oxygen and groundwater pH at individual wells may explain why reductive dechlorination is apparently very effective at some locations and is less effective at other

monitoring points. Figure 15 shows individual plots of the dissolved oxygen, pH, PCE, TCE, cis 1,2-DCE and vinyl chloride for four monitoring wells. Each well shown is discussed below.

Well B-3 initially had concentrations of PCE and TCE above performance standards, PCE and TCE concentrations declined then rebounded, and finally dropped again. Later results saw significant increases in the concentrations of both cis 1,2-DCE and vinyl chloride. The pH increased between the first (pre-injection) sample and later sample events, and all of the pH values measured during the injection period were within the optimal range for reductive dechlorination. The dissolved oxygen concentration was very high prior to the first lactate injection. The next dissolved oxygen concentration was still well above the favorable range for reductive dechlorination; however, there was an already increasing concentration of both cis 1,2-DCE and vinyl chloride, and conditions were becoming more favorable for reductive dechlorination. The last two dissolved oxygen concentrations were both within the favorable range for reductive dechlorination, and the concentrations of chlorinated ethenes reflect the more favorable geochemical environment, with decreasing concentrations of parent compounds and increasing concentrations of daughter compounds.

Before the first lactate injection, well B-2 had a very high dissolved oxygen concentration, and both PCE and TCE exceeded their respective performance standards. The pH was 5.89 and probably unfavorable for reductive dechlorination. The next dissolved oxygen measurement and two pH measurements saw conditions become more favorable for reductive dechlorination. Initially, the PCE and TCE concentrations decreased in response to the lactate injection at B-2, but later rebounded, even though conditions were becoming more favorable for reductive dechlorination. As noted above, it is possible that the B-2 rebound was caused by migration of previously immobilized and relatively highly contaminated groundwater into the vicinity of B-2 as a result of the cessation of pumping in the area. The final dissolved oxygen and pH measurements at B-2 were both in the favorable range for reductive dechlorination. In the most recent groundwater sample, the PCE and TCE concentrations were nondetect, and cis 1,2-DCE and vinyl chloride had increased relative to the previous sample. Well B-2 provides a good example of how dissolved oxygen and pH conditions affect removal of PCE and TCE via reductive dechlorination.

Before the first lactate injection, the A-3 pH was 6, the dissolved oxygen concentration was 4.29 mg/L, PCE and TCE exceeded performance standards, and there was no evidence of significant reductive dechlorination. The subsequent pH measurement from February 2006 was above 7, but no dissolved oxygen measurement was made. Both PCE and TCE concentrations decreased appreciably; however no production of cis 1,2-DCE or vinyl chloride was apparent. If the chlorinated ethenes were not degraded to completely non-chlorinated end products, this pattern suggests that the February 2006 data represented a groundwater sample reflecting dilution of the contamination through the repeated lactate injections prior to that sample, with the dissolved oxygen concentration probably limiting the reductive dechlorination process. Later samples showed that the pH was between 6.11 and 6.61, while dissolved oxygen remained above 1 mg/L. Although some production of cis 1,2-DCE and vinyl chloride is apparent, both TCE and PCE concentrations increased after February 2006. Well A-3 is an example of a location where the

improvement of geochemical conditions for reductive dechlorination has not advanced to the point that conditions are very favorable. Meanwhile, an apparent influx of PCE and TCE has added more contaminant mass to the vicinity of well A-3, offsetting the improvement in geochemical conditions.

In the September 2004 sample collected shortly before initiation of lactate injection, Well DP-3-1 had a reported initial pH of 3.1 and a dissolved oxygen concentration of 6.59 mg/L. These environmental conditions were very unfavorable for reductive dechlorination. After the first large-scale lactate injection, the DP-3-1 groundwater sample from December 2004 had a pH of 7.3, a dissolved oxygen concentration of 3.16 mg/L, and contained appreciably less PCE and TCE and much more cis 1,2-DCE than the pre-treatment sample. The following sample from February 2005 had an even higher cis 1,2-DCE concentration and an increasing vinyl chloride concentration, and declining dissolved oxygen. The PCE and TCE concentrations had also increased from December 2004 to February 2005, indicating some movement of more contaminated groundwater into the area of DP-3-1 between sample events. Later samples, however, showed that PCE and TCE contamination dissipated at DP-3-1, with varying concentrations of cis 1,2-DCE and vinyl chloride. The groundwater pH remained at about 7, while with one anomalous exception, the dissolved oxygen dropped to below or slightly above the favorable zone for reductive dechlorination (less than 0.5 mg/L). DP-3-1 appears to be an example of a well where multiple large-scale injections of lactate solution have dramatically altered the geochemical environment to a condition very favorable for reductive dechlorination.

A final question concerns the groundwater pH over time. As noted in the article by Robinson et al, groundwater pH will decrease as a result of reaction between chlorinated ethenes and organic substrates. This process can result in development of groundwater geochemistry that is unfavorable for further reductive dechlorination. A review of the pH conditions over time was made, to determine if there were any apparent long-term changes in pH resulting from reductive dechlorination.

Exploratory data analysis was done using the boxplot method of sample population representation. Figure 16 shows the results of the exploratory analysis. Note that among the features shown on the boxplots are the upper and lower 95% confidence limits on the median of the sample population. Where the area of a boxplot encompassed by the 95% confidence interval on the median overlaps with the 95% confidence interval on the median for another sample population, there would be no nonparametric statistical test (at the specified probability of a type I statistical error) that would demonstrate a probable dissimilarity between the two averages. Figure 16 shows that with the possible exception of the last two sample populations, there is overlap of the 95% confidence intervals for the median pH of all the sample populations. In summary, the available data do not suggest a pervasive trend of decreasing sample pH. Figure 16 does suggest that over time, the groundwater pH has become less variable.

Summary and Conclusions

In late 2004, the groundwater extraction and treatment remedial action at the Medley Farm Site was suspended. Enhanced reductive dechlorination was attempted to determine if a change in the groundwater remedial strategy was warranted. Since that time, there have been several injections of an organic carbon source into the groundwater in an attempt to produce conditions more favorable for reductive dechlorination. This report was prepared to evaluate the progress of the reductive dechlorination efforts at the Medley Farm Site and to recommend further steps to advance the groundwater remedial action to reach the performance objectives for groundwater cleanup.

This report evaluated groundwater monitoring data from deep bedrock or lower saprolite wells. These wells were selected for data evaluation because of the spatial distribution of groundwater contamination and the amount of monitoring data available for evaluation.

By the time of the completion of Second Five-Year Review for Medley Farm (July 2004), the groundwater contaminants of concern were essentially chlorinated solvents. The most prevalent and environmentally significant chlorinated solvent contamination at that time was by PCE, TCE, and their degradation products cis 1,2-DCE and vinyl chloride. This report focuses on these chlorinated ethene contaminants in an evaluation of the progress of the groundwater remedial action.

Groundwater remedial action at the Medley Farm Superfund Site began in 1995 with the operation of a pump and treat system of 11 recovery wells. Later, three dual-phase wells were added that recovered both contaminated groundwater and soil vapor. By the time of the last Five Year Review in July 2004, the pump and treat system had reportedly removed 243 pounds of volatile organic compounds and over 100 million gallons of groundwater. Predictably, the rate of contaminant mass removal decreased dramatically as the recovery well system operated through successive years.

In late 2004, injection of a carbon source (sodium lactate solution) began at the Medley Farm Site. The lactate injection was intended to enhance the reductive dechlorination of chlorinated organic compounds and the removal of these contaminants from the groundwater. EPA, DHEC, and the PRPs agreed that the pump and treat groundwater remedial action appeared to be at or approaching a point at which further reductions of contaminant concentrations or contaminant mass would be inefficient. From late 2004 until the present, there have been five lactate injection events of varying intensities.

This report used a variety of data evaluation procedures in order to evaluate the progress of the remedial action during the enhanced reductive dechlorination period. Included in these procedures were evaluations of trends in total chlorinated ethene concentrations, parent-daughter molar ratio analyses, evaluation of contaminant concentration rebound following lactate injections, and evaluation of how indicators of the geochemical environment have changed in response to lactate injections and resting periods between lactate injections.

Total chlorinated ethene trends were evaluated to determine how the concentrations of the principal contaminants of concern have changed over time both prior to the first lactate injection and then after the start of lactate injections. Temporal trends were evaluated using both a series of plots of concentrations on a site base map and through exploratory statistical analysis. A sampling event from slightly more than one year after the first lactate injection and following a total of three lactate injection events showed a dramatically lower concentration of chlorinated ethenes relative to the three pre-injection sample events that were evaluated. Later sample events during the period of lactate injection showed total chlorinated ethene concentrations that were somewhat lower than pre-injection concentrations, but that were higher than the first sample event evaluated for the lactate injection period. This analysis demonstrated the overall beneficial results from lactate treatment of the groundwater, as well as indicating the presence of sources of contaminant mass flux to the dissolved phase that were apparently either not directly treated, or were not very effectively addressed by the lactate injection. The evaluation of total chlorinated ethenes does not consider potentially significant changes in the proportions of the different chlorinated ethenes present. In order to evaluate the development of greater concentrations of degradation daughter products versus parent compounds, parent-daughter ratio plots were created.

The parent-daughter plots show an overall trend of increasing cis 1,2-DCE + vinyl chloride relative to PCE+TCE as the lactate injections occurred. There was more PCE+TCE than cis 1,2-DCE+vinyl chloride in all samples evaluated for the pre-injection period. Most wells had a PCE+TCE to cis 1,2-DCE+vinyl chloride ratios of less than 1 during the lactate injection period. There are areas where even after multiple lactate injections, there was still more PCE+TCE versus cis 1,2-DCE+vinyl chloride. This condition is not surprising, as there are undoubtedly aquifer volumes where there is a greater resistance to geochemical modification through reductive dechlorination.
Data from the period of lactate injections show a smaller range in parent-daughter concentration ratios for each successive sampling event. Such a condition is consistent with a spreading of the lactate solution, or spreading of the altered geochemical conditions resulting from the lactate injection. Molar concentration ratios have also decreased substantially relative to pre-injection conditions, demonstrating the overall positive response of the groundwater chemistry to the lactate injections. The presence of several areas of positive molar concentration ratios after repeated lactate injections probably reflects the inability of geochemical modifications via lactate injection to offset preexisting local geochemical conditions that were especially unfavorable for reductive dechlorination, combined with the inability of the lactate applications to overcome any addition of relatively untreated contamination from residual sources such as recharge or back-diffusion out of the aquifer matrix.

An important question concerning the treatment of groundwater to enhance reductive dechlorination is whether or not such treatment creates long-lasting improvements in the geochemical environment and chlorinated solvent concentrations. To more thoroughly evaluate the long-term effectiveness of reductive dechlorination, concentration rebound plots were created. These concentration rebound plots show the dates and volumes of lactate solution

injected at each well and the concentrations of PCE, TCE, cis 1,2-DCE, and vinyl chloride over time at each injection well.

The concentration rebound plots indicate effective reductive dechlorination has occurred at some injection points, while in localized areas, the reductive dechlorination process has been less effective or incomplete, despite repeated applications of lactate. Some of the apparent areas of inefficient lactate injection are probably explained by movement of untreated or partially treated groundwater out of stagnation zones (zones of inconsequential groundwater flow) present between extraction wells before pumping stopped. This cause of contaminant rebound will be transient, as a sufficient period of groundwater movement under ambient hydraulic conditions will move the previously immobilized dissolved-phase contamination past downgradient wells. For other injection wells, the inability of lactate injection to effectively suppress PCE and TCE concentrations appears to be a result of some other residual source(s) of PCE and TCE. The different responses of injection wells to lactate injections is very localized, reflecting the different hydraulic properties around individual injection wells, the presence of stagnation zones of various dimensions and contaminant masses within them, the presence of potential additional sources of residual contaminant mass, lactate injection rates and timing, and other factors. Generally, however, the rebound plots show that lactate injection has been successful in producing conditions favorable for reducing the concentrations of PCE and TCE in the vicinity of the injection wells.

In many biodegradation settings, there is an inability of the microbial population to degrade cis 1,2-DCE to vinyl chloride. For Medley Farm, the concentration rebound plots show production of vinyl chloride at most locations.

Dissolved oxygen and pH were evaluated to determine how these variables are changing over time in response to the lactate injections and to see where environmental conditions were more or less favorable for biodegradation of chlorinated ethenes through reductive dechlorination. The environmental favorability for reductive dechlorination has been improving since the first lactate injection, with conditions during the last two monitoring events (September 2007 and early 2009) being generally much more favorable for reductive dechlorination than conditions during the previous sampling events from late 2004 through late 2006.

A review of dissolved oxygen, pH, and chlorinated ethene data from selected individual monitoring wells reveals that environmental conditions (primarily indicated by the dissolved oxygen) have a generally strong correlation with the reductive dechlorination of the chlorinated ethenes. Where there are exceptions, it appears they are largely explained as a result of influx of untreated or marginally treated groundwater into the area of the injection wells. Such addition of parent compound mass likely offsets the improving environmental conditions for reductive dechlorination. Dissolved oxygen concentrations somewhat above 0.5 mg/L are not necessarily associated with the absence of reductive dechlorination. However, a 5 mg/L dissolved oxygen concentration as an indicator of unfavorable conditions appears valid.

A review of the groundwater pH conditions over time was made, to determine if there were any apparent long-term changes in pH resulting from reductive dechlorination. No change in the median groundwater pH is apparent. The groundwater pH may be becoming less variable over time.

Reductive dechlorination as a groundwater remediation strategy has generally been an improvement over the pump and treat remedial action. At many monitored locations, lactate injection appears to either have resulted in attainment of remedial objectives, or has created conditions that will likely result in attainment of remedial objectives for groundwater.

Apparent problems with the reductive dechlorination remedial action have probably mostly been due to movement of contaminated groundwater out of stagnation zones after groundwater extraction stopped. Such movement of untreated groundwater has caused some rebound in concentrations of parent chlorinated solvents or has otherwise slowed groundwater quality responses to the lactate injections. This cause of concentration rebound or slow response to reductive dechlorination is transient. Additionally, the lactate injection has had to overcome the presence of initial geochemical conditions that were generally not conducive to reductive dechlorination. This condition has required multiple lactate injections in order to produce conditions favorable or somewhat favorable for reductive dechlorination.

There are undoubtedly some areas where contaminant movement out of the aquifer matrix, contaminant desorption or through recharge through incompletely removed contaminant mass above the water table has slowed the removal of contaminants by reductive dechlorination. These factors contributing to slow remedial progress affect the progress of other groundwater remedial actions, such as the groundwater extraction and treatment that was done prior to the lactate injections. The notable localized areas that appear to show some ongoing introduction of parent compounds to the groundwater are around extraction/injection wells DP-2-1, A-3, and probably A-5. These areas will likely require further targeted lactate applications or other remedial actions to attain remedial objectives.

The enhanced reductive dechlorination has generally produced both cis 1,2-DCE and vinyl chloride as degradation products of the chlorinated ethenes PCE and TCE. Reductive dechlorination of vinyl chloride is typically a slower process than reductive dechlorination of its parent compounds. This relative rate of dechlorination factor can produce an accumulation of vinyl chloride in the reducing environment. Such a condition may be present at a few monitoring locations. However, any vinyl chloride that is transported by the groundwater out of the zone of reductive dechlorination is likely to move into a geochemical environment characterized by low organic carbon concentrations and an oxidizing environment. Under such conditions, vinyl chloride can be rapidly oxidized (Wiedemeier et al, 1996).

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Figure 1. Wells with Data Considered in this Report

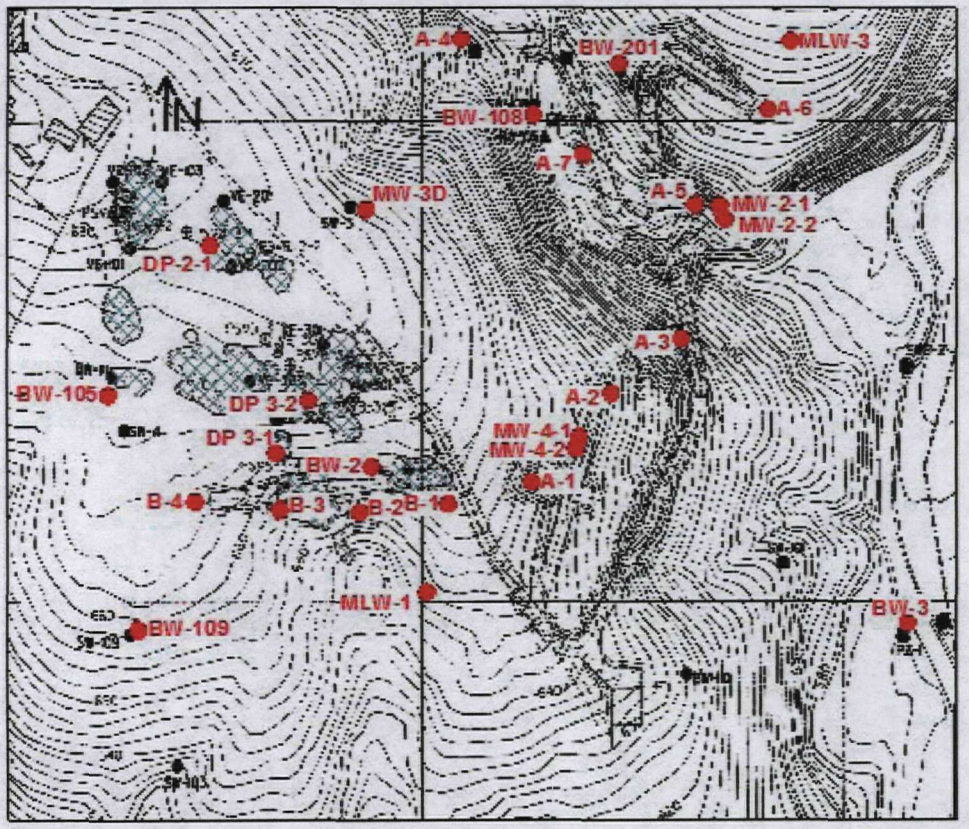


Figure 2. Source Areas, Recovery Wells and Dual Phase Recovery Wells

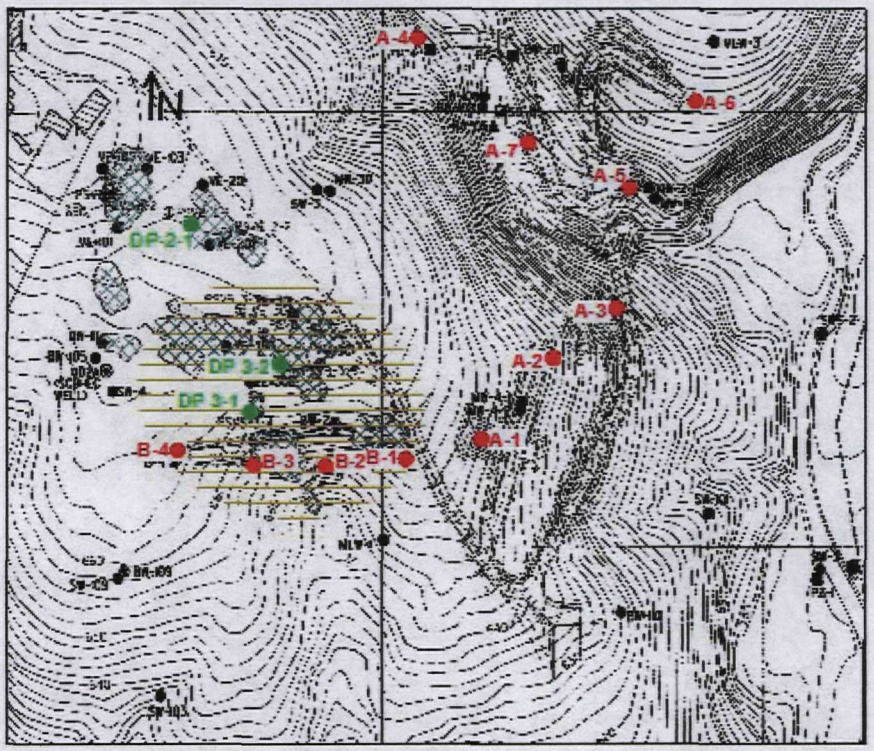


Figure 3. Trends in Chlorinated Ethene Compounds

(PCE, TCE, cis 1,2-DCE and vinyl chloride, summed concentration in mg/L)

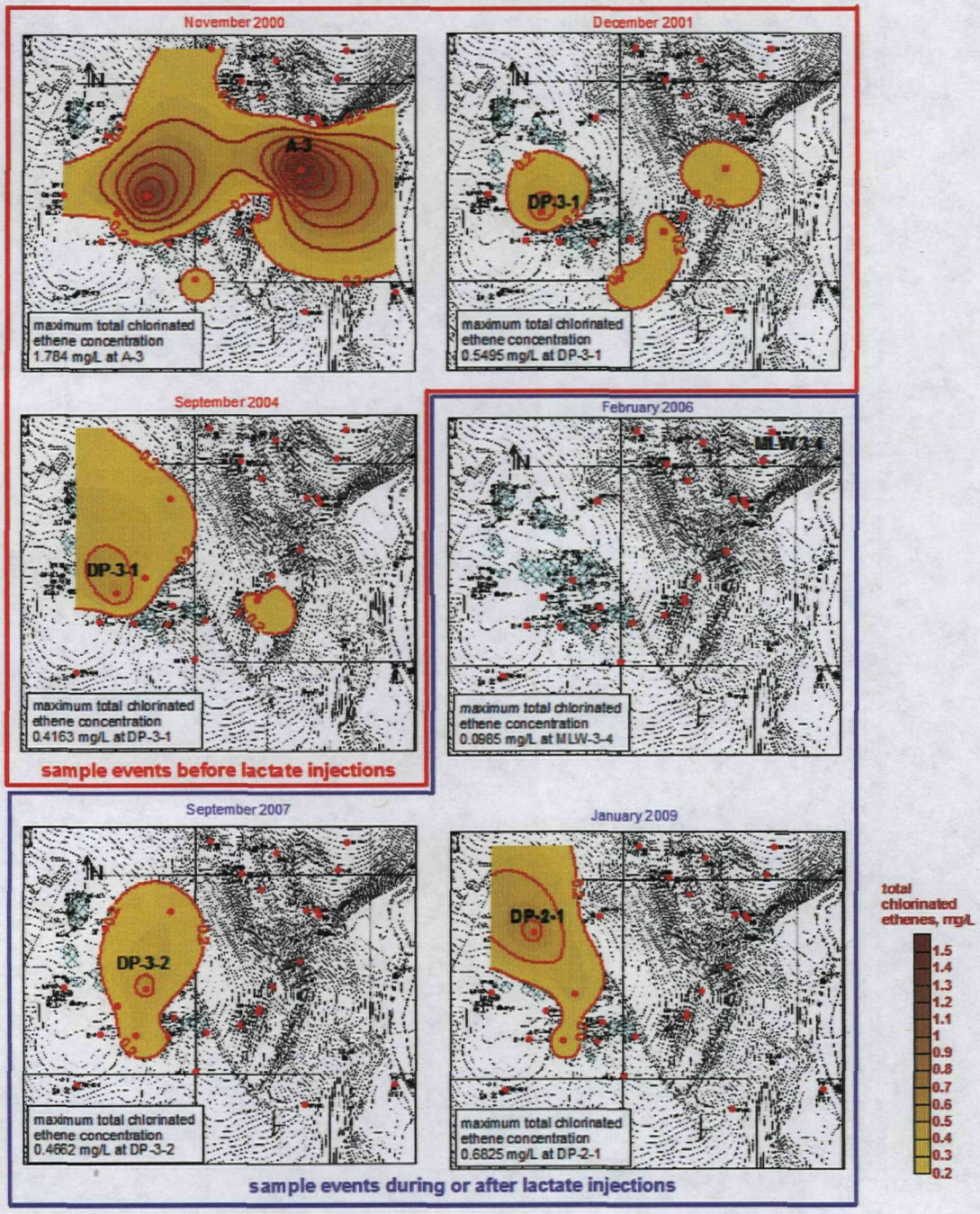
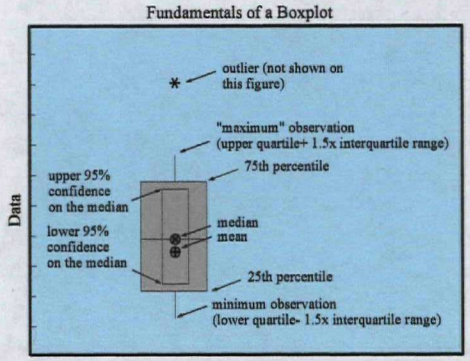


Figure 4. Boxplot Representations of Total Chlorinated Ethene Concentrations for Pre and Post-injection Monitoring Events



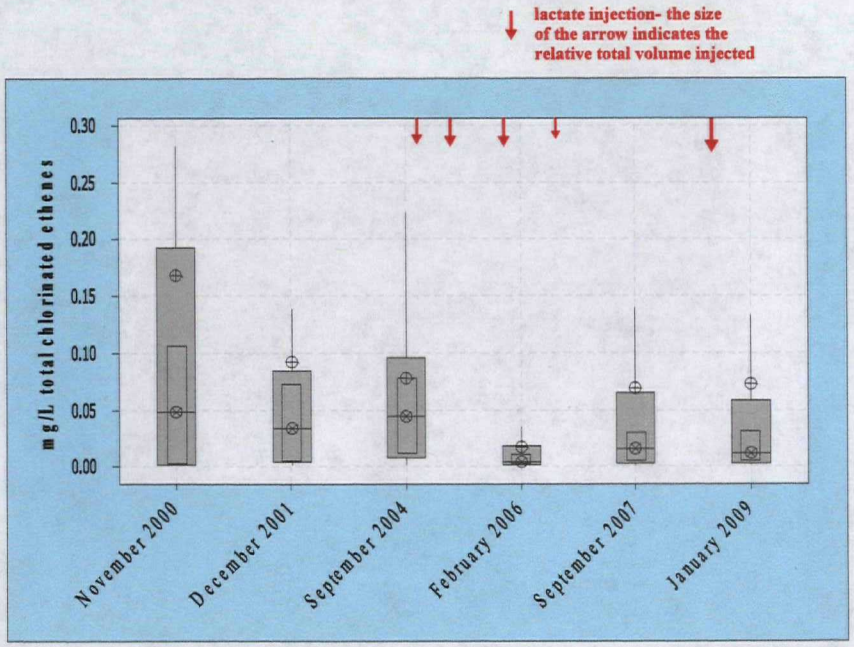


Figure 5. Log-Scale Molar Ratio of PCE+TCE/cis 1,2-DCE+Vinyl Chloride

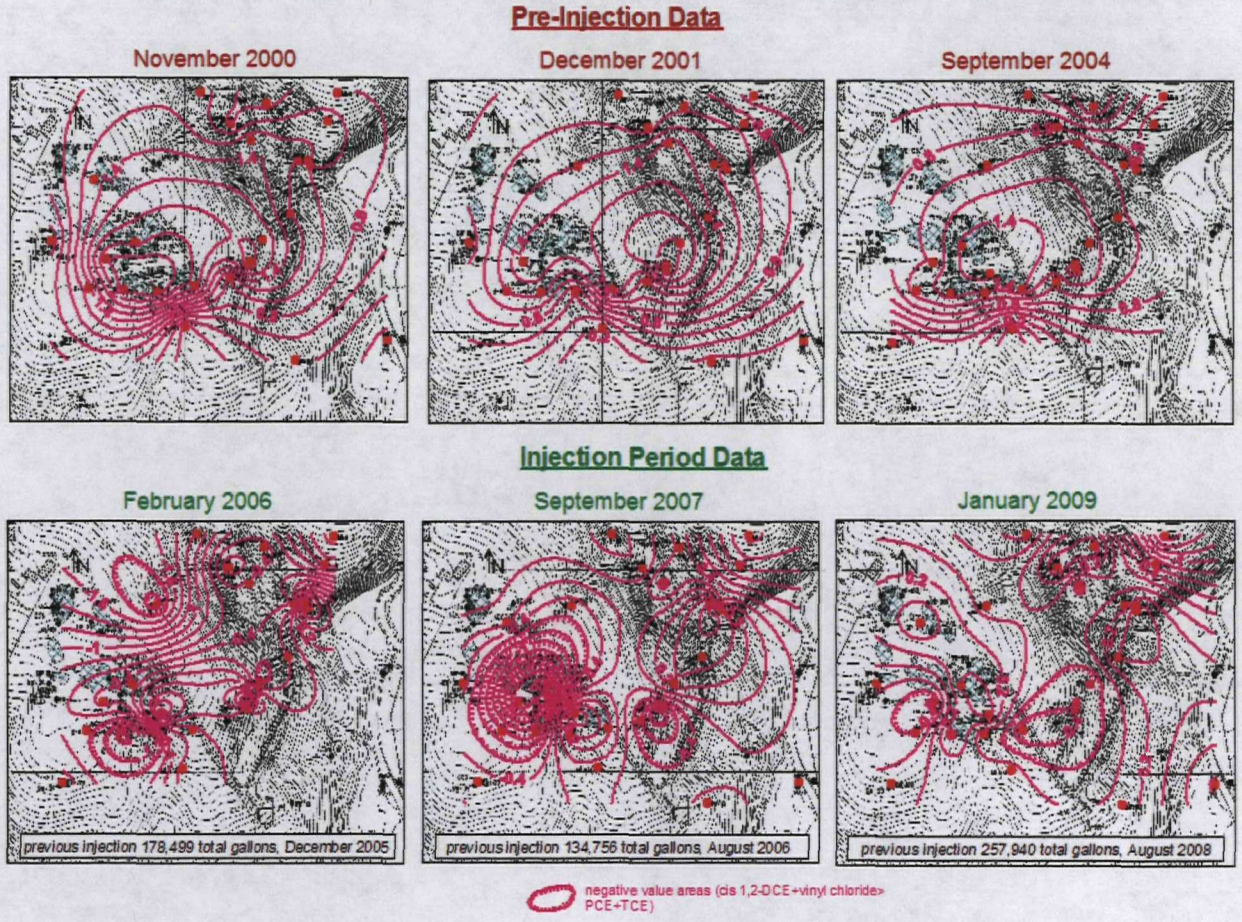


Figure 6. Temporal Changes in log Ratio of PCE+TCE to cis 1,2-DCE+Vinyl Chloride, Injection Period Data

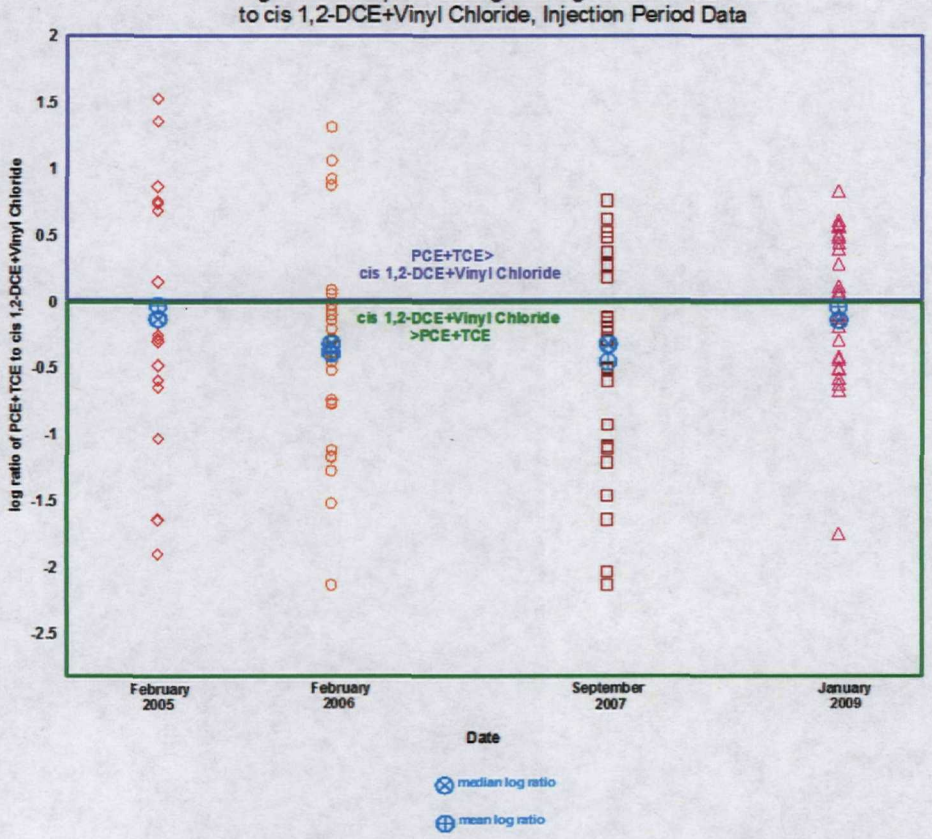


Figure 7. Log Molar Concentration Ratio PCE+TCE to cis 1,2-DCE+Vinyl Chloride Injection Well to Monitoring Well Comparison, February 2006 Data

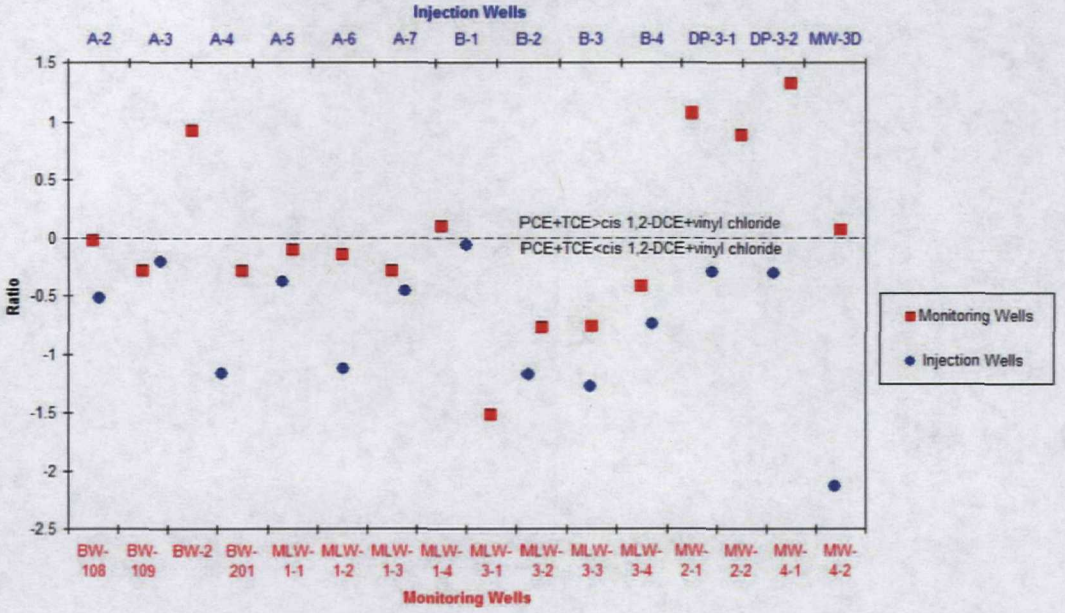


Figure 8. Log Molar Concentration Ratio PCE+TCE to cis 1,2-DCE+Vinyl Chloride Injection Well to Monitoring Well Comparison, September 2007 Data

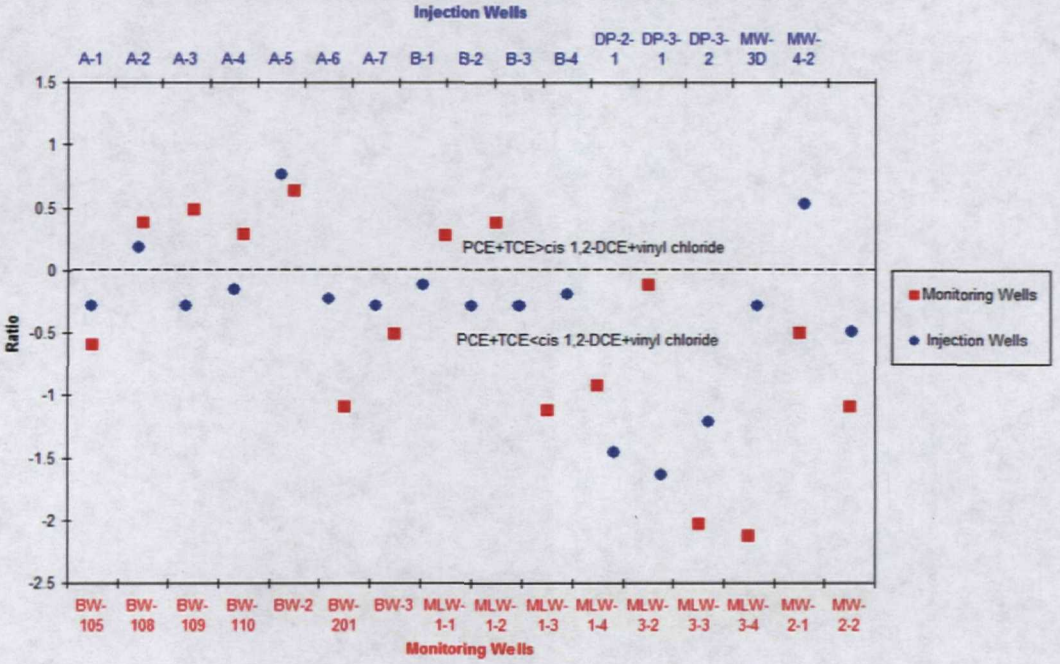


Figure 9. Log Molar Concentration Ratio PCE+TCE to cis 1,2-DCE+Vinyl Chloride Injection Well to Monitoring Well Comparison, January 2009 Data

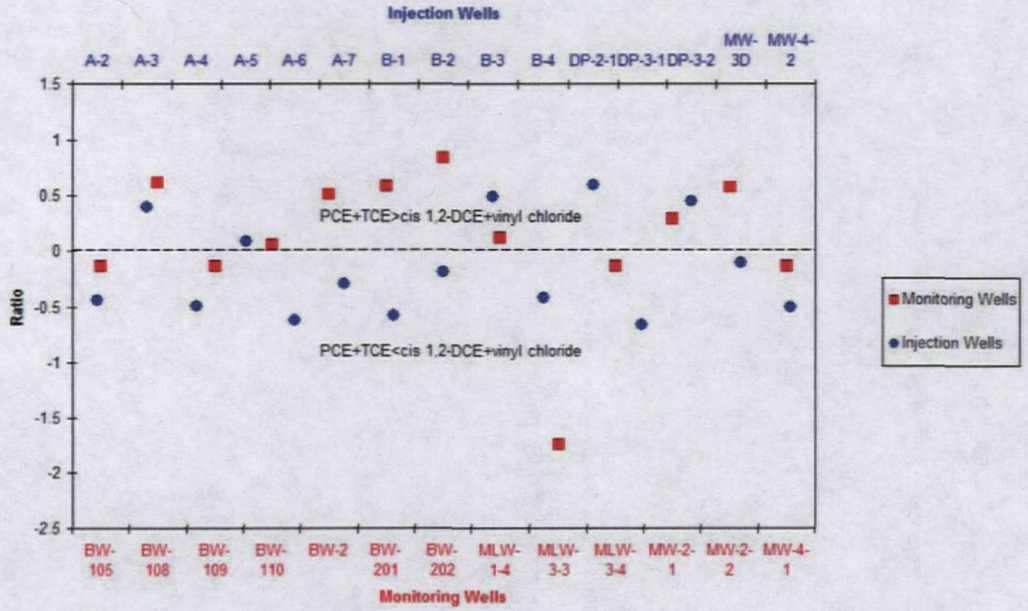


Figure 10. PCE+TCE/cis 1,2-DCE+Vinyl Chloride Molar Ratio Concentration Trends for Wells at Various Distances from the Contaminant Source Areas

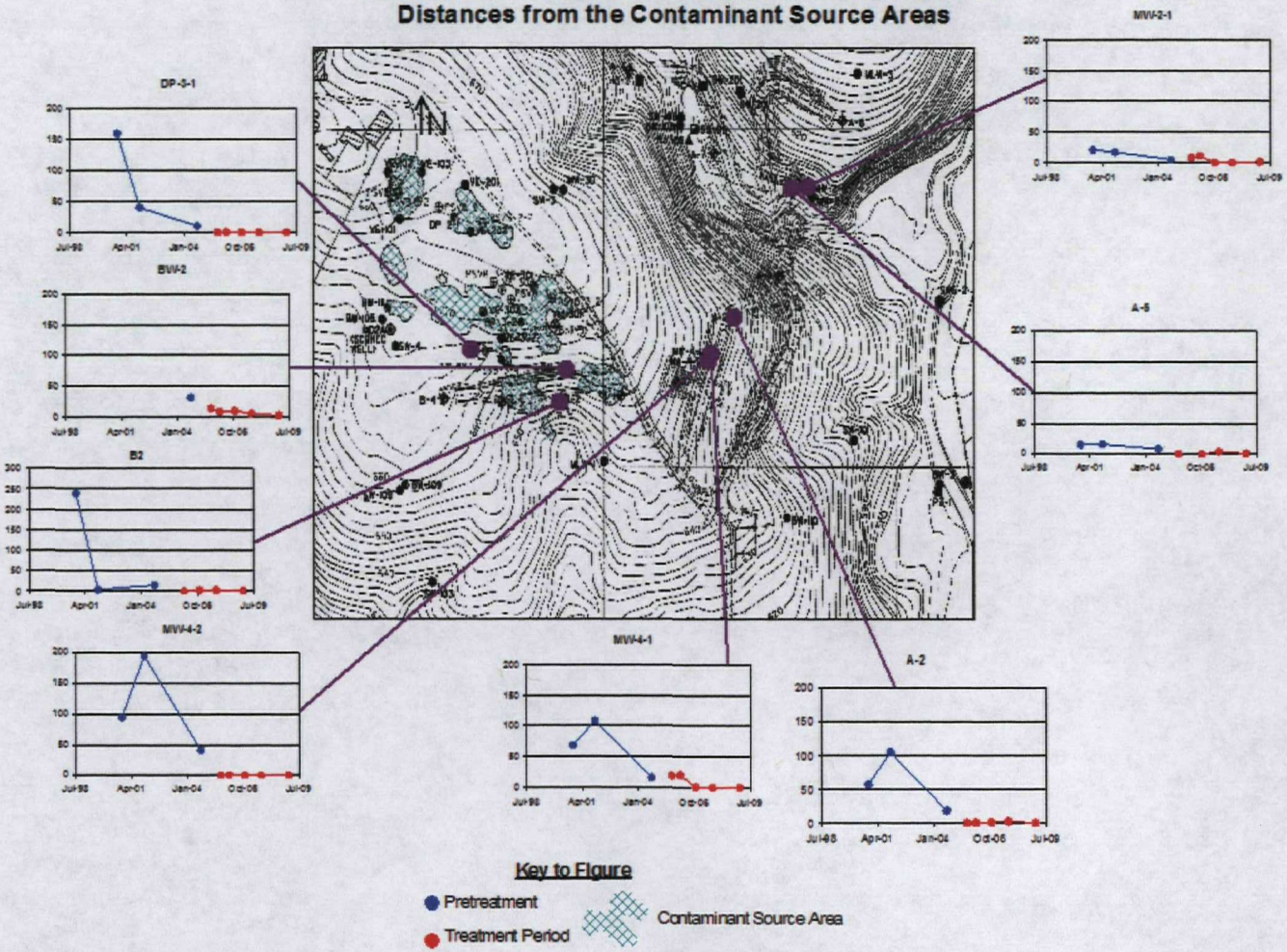


Figure 11. Concentration Rebound Plots for Wells Closer to the Contaminant Source Areas

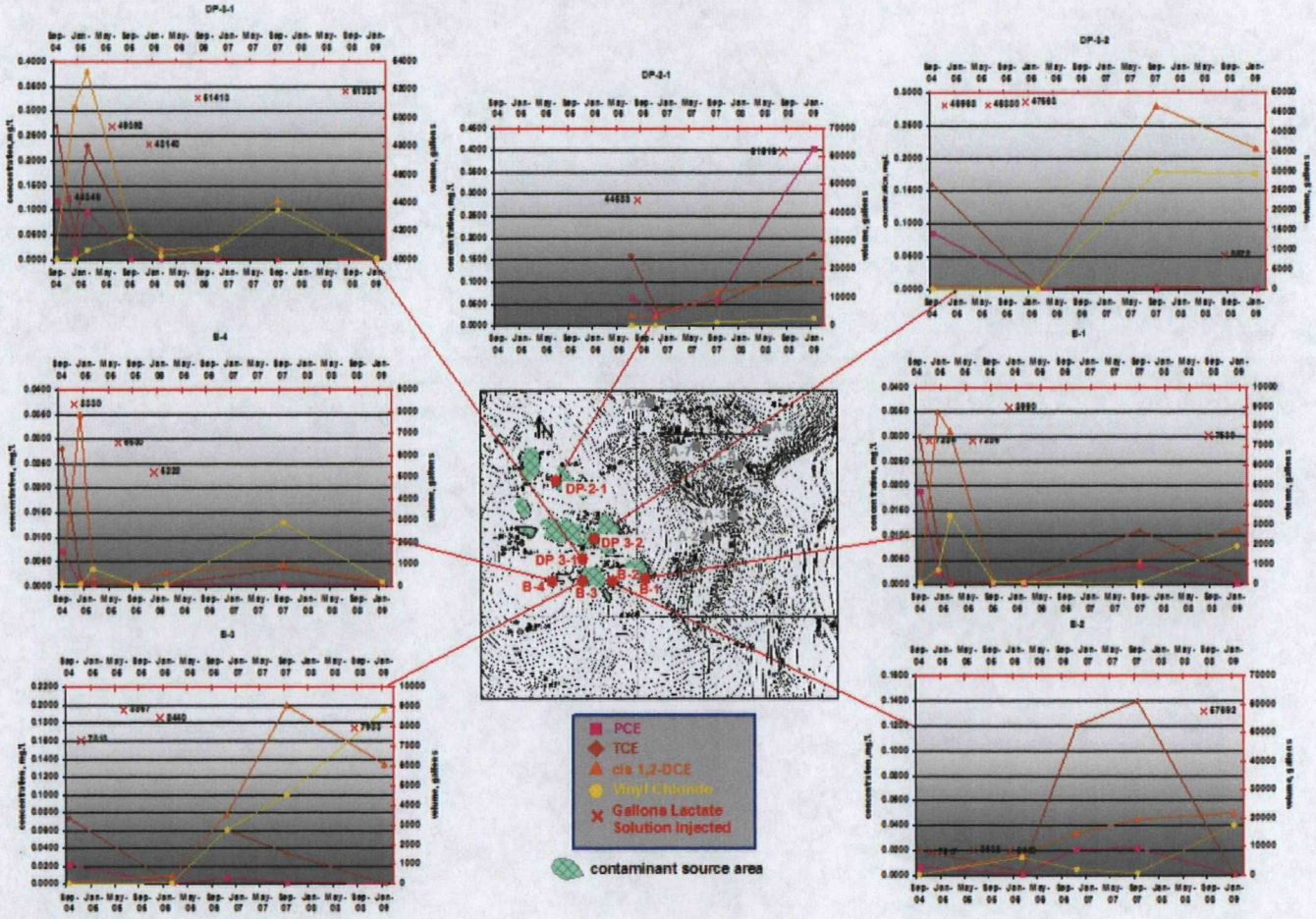


Figure 12. Concentration Rebound Plots for Wells Farther from the Contaminant Source Areas

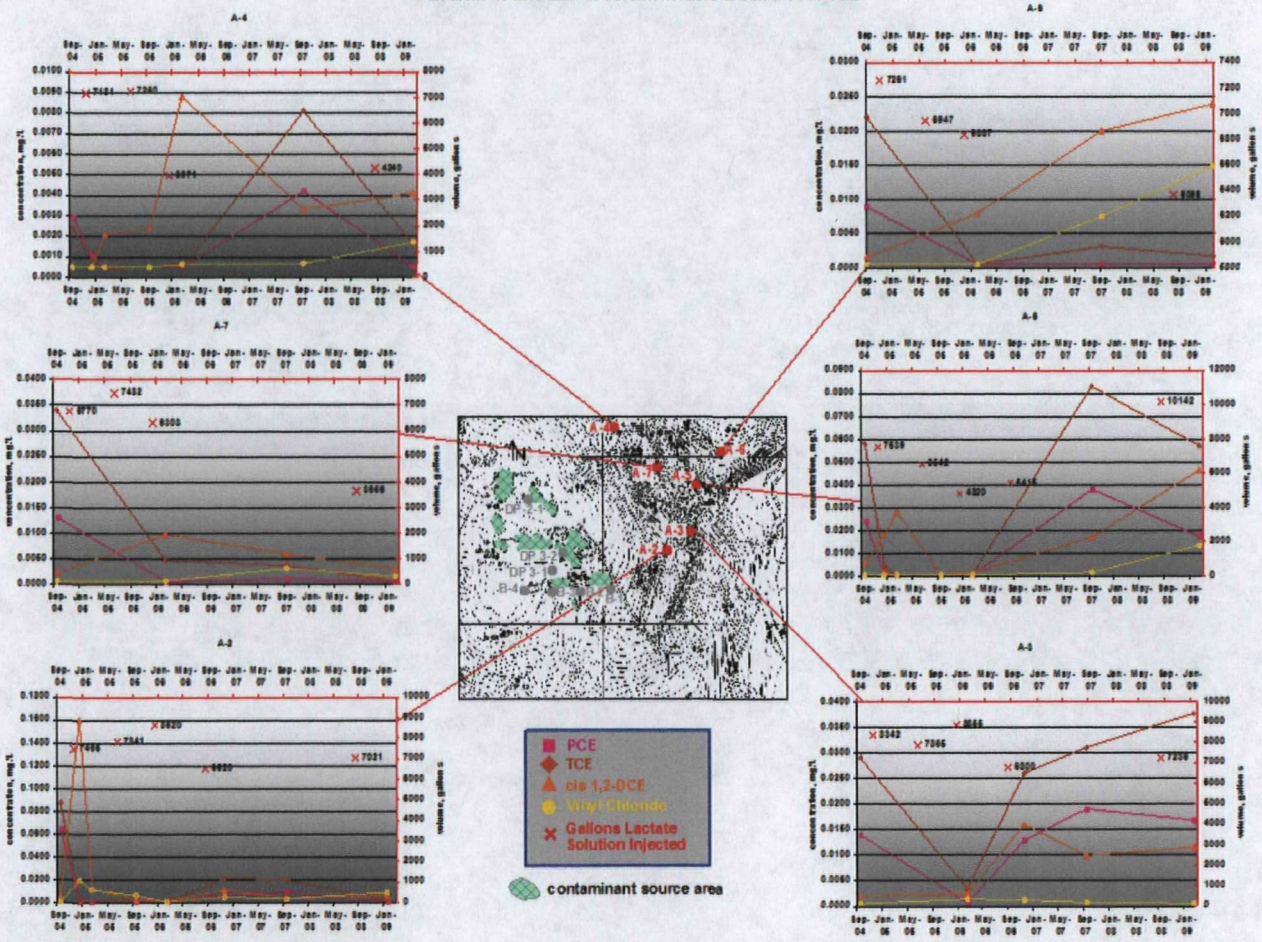
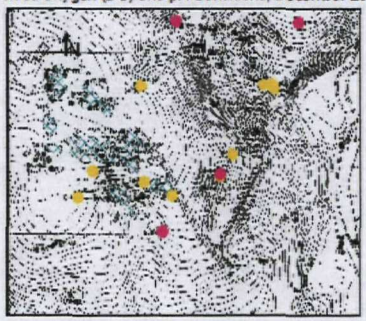
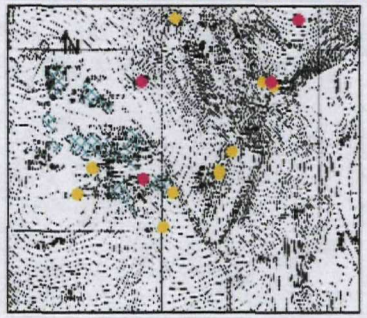


Figure 13. Dissolved Oxygen and pH Conditions Over Time Since the Initiation of Lactate Injection

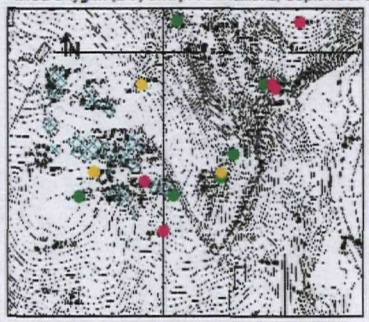
Dissolved Oxygen (DO) and pH Conditions, December 2004



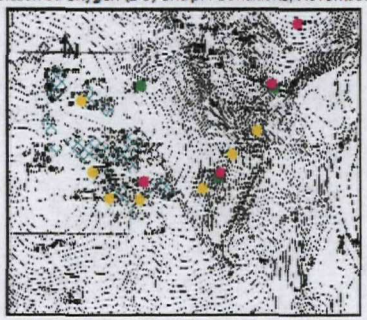
Dissolved Oxygen (DO) and pH Conditions, February 2005



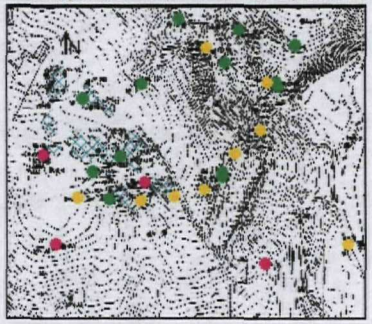
Dissolved Oxygen (DO) and pH Conditions, September 2005



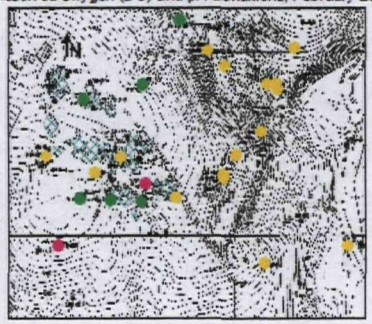
Dissolved Oxygen (DO) and pH Conditions, November 2006



Dissolved Oxygen (DO) and pH Conditions, September 2007



Dissolved Oxygen (DO) and pH Conditions, February 2009



- Dissolved Oxygen/pH Suitable for Reductive Dechlorination (DO < 0.5 mg/L; 5<pH<9)
- Dissolved Oxygen/pH Marginal to Unfavorable for Reductive Dechlorination (0.5 mg/L<DO<5 mg/L +/- pH>9 or pH<5)
- Dissolved Oxygen Unsuitable for Reductive Dechlorination (DO>5 mg/L)
- Contaminant Source Area

Figure 15. Relationship Between Chlorinated Ethene Concentrations, pH, and Dissolved Oxygen Concentrations at Four Injection Wells

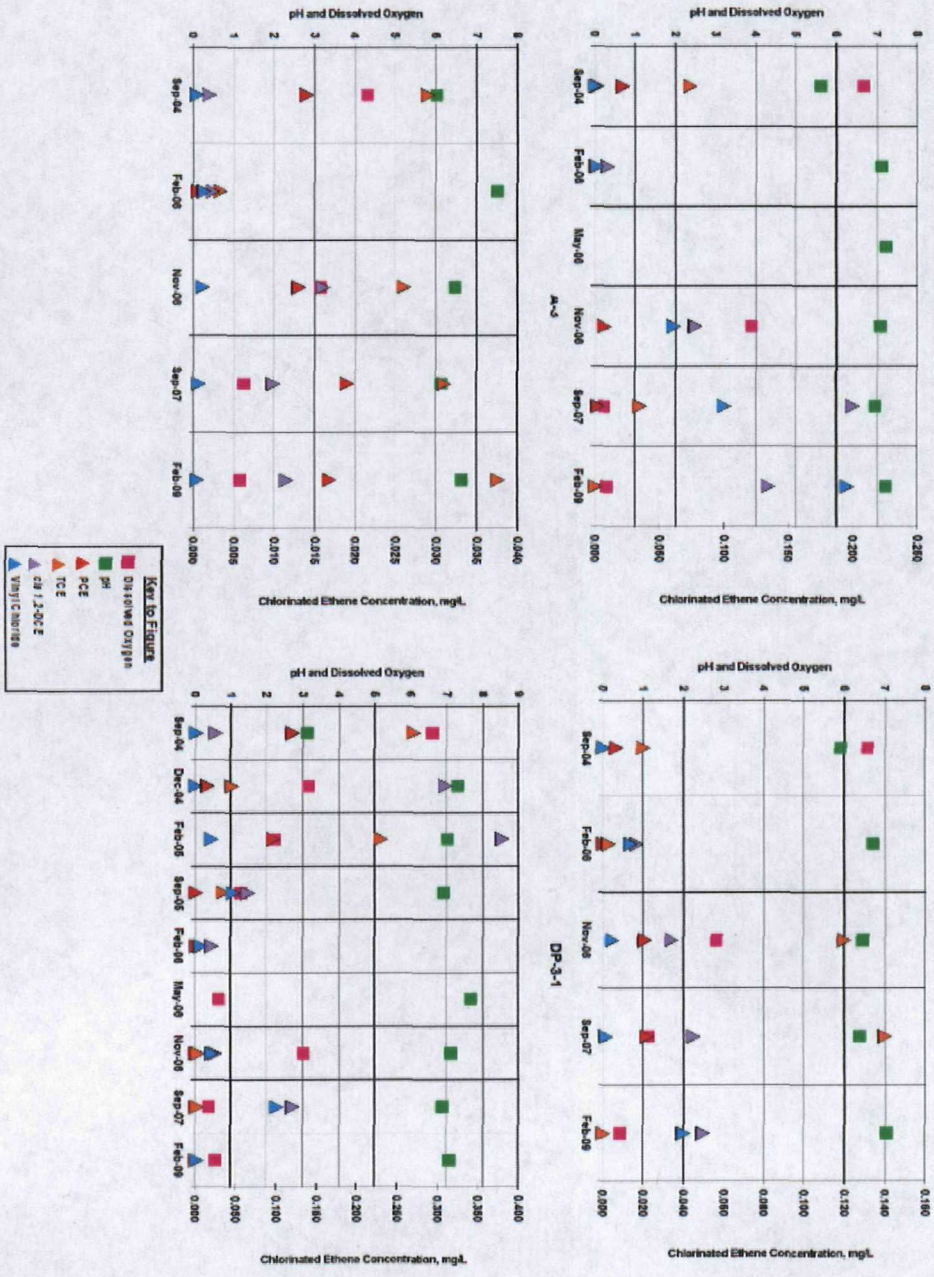


Figure 14. Response of Dissolved Oxygen Concentrations in Bedrock and Lower Saprolite Groundwater to Lactate Injection Events

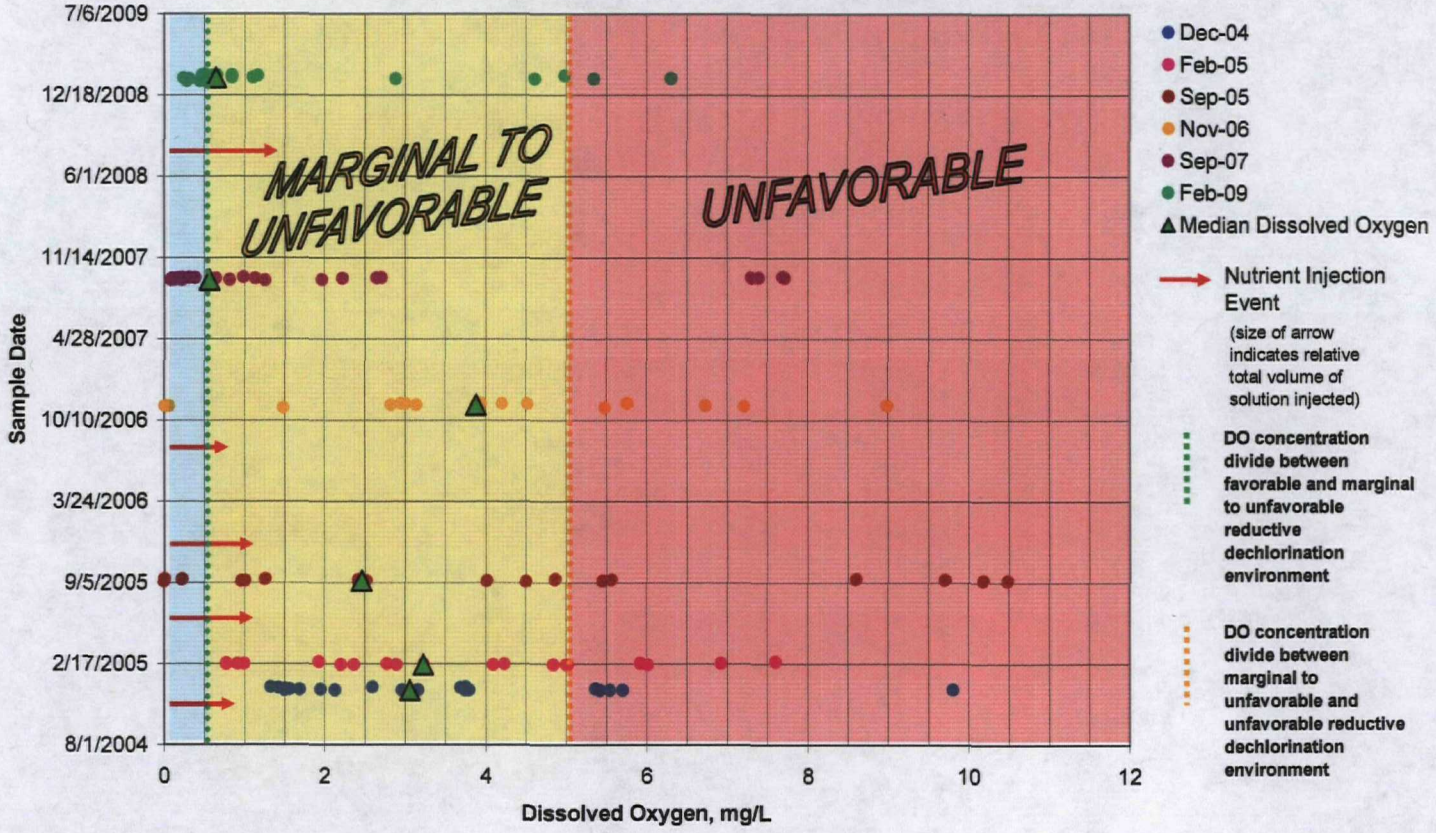


Figure 15. Relationship Between Chlorinated Ethene Concentrations, pH, and Dissolved Oxygen Concentrations at Four Injection Wells

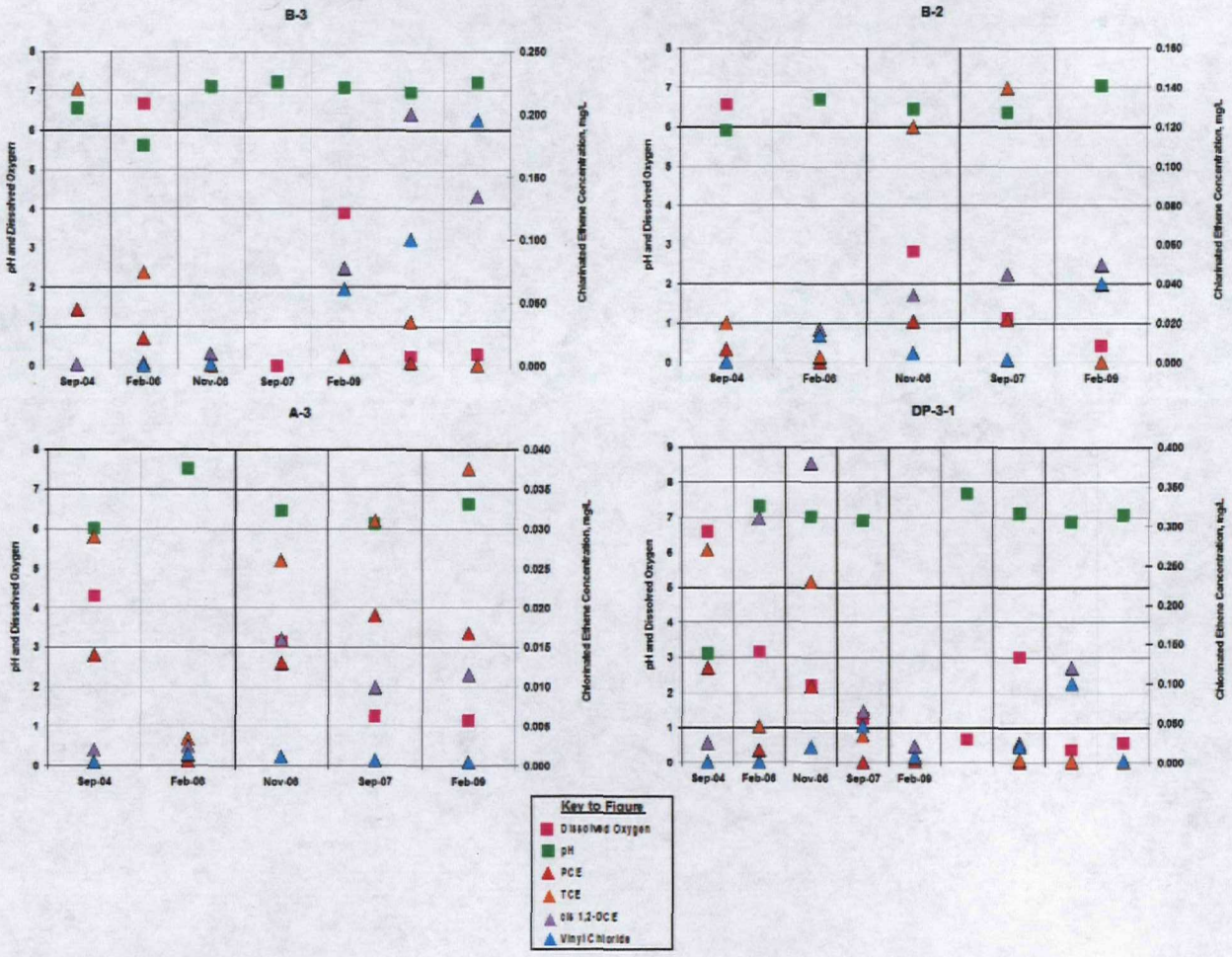
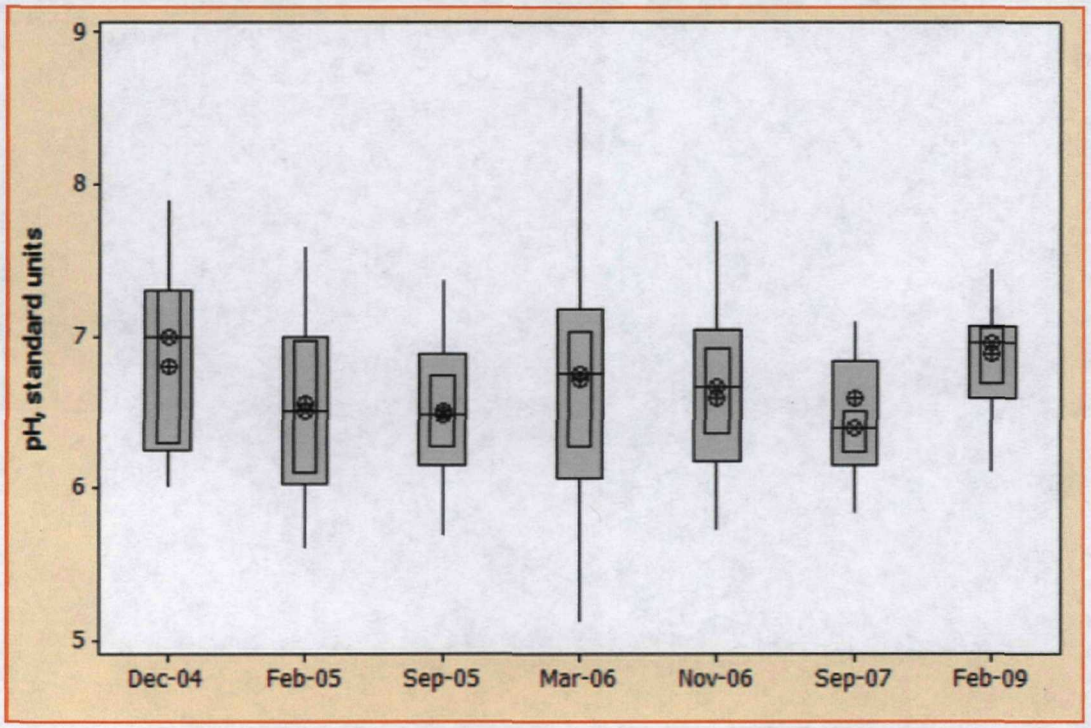
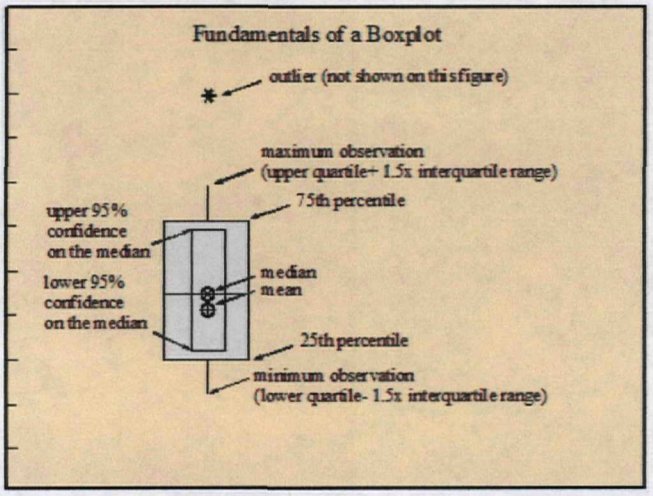


Figure 16. Boxplots of Lactate Injection Period pH Sample Populations





Item 2
Tabulated Data, Groundwater Sampling 2004 – 2009

Table 2

Summary of Volatile Organic Compounds and Degradation Products in Groundwater

Medley Farm NPL Site

Station	Sample Date	Tetrachloroethene (mg/L)	Trichloroethene (mg/L)	cis-1,2-Dichloroethene (mg/L)	trans-1,2-Dichloroethene (mg/L)	1,1-Dichloroethene (mg/L)	Vinyl chloride (mg/L)
A-1	9/22/04	0.034	0.049	0.0044	<0.001	<0.001	<0.001
A-2	9/22/04	0.065	0.087	0.0048	<0.001	0.0023	<0.001
A-2	12/15/04	<0.002	<0.002	0.16	<0.002	0.002 J	0.019
A-3	9/23/04	0.014	0.029	0.002	<0.001	0.0019	<0.001
A-4	9/23/04	0.0029	0.0024	<0.001	<0.001	<0.001	<0.001
A-4	12/16/04	0.0011	0.00087 J	<0.001	<0.001	<0.001	<0.001
A-5	9/30/04	0.024	0.058	0.0057	<0.001	0.0034	<0.001
A-5	12/20,21/04	0.0012 M	0.004 M	0.018 M	<0.001 M	0.00058 MJ	<0.001 M
A-6	9/23/04	0.0089	0.022	0.0016	<0.001	0.0013	<0.001
A-7	9/23/04	0.013	0.034	0.0022	<0.001	0.0017	<0.001
B-1	9/23/04	0.019	0.03	<0.001	<0.001	<0.001	<0.001
B-1	12/16/04	0.0026 M	0.0085 M	0.035 M	<0.001 M	0.00093 MJ	0.003 M
B-2	9/23/04	0.0067	0.02	<0.001	<0.001	0.0011	<0.001
B-3	9/23/04	0.022	0.074	0.0023	<0.001	0.004	<0.001
B-4	9/23/04	0.0072	0.028	0.0011	<0.001	0.0032	<0.001
B-4	12/20/04	<0.001	0.0014	0.035	<0.001	0.0052	0.00049 J
BW-108	9/16/04	0.0057	0.0065	<0.001	<0.001	<0.001	<0.001
BW-109	9/21/04	<0.001	<0.001	<0.001	<0.001	0.0016	<0.001
BW-2	9/21/04	0.025	0.035	<0.001	<0.001	<0.001	<0.001
BW-2	12/16/04	0.0086	0.029	<0.001	<0.001	<0.001	<0.001
BW-201	9/14,15/04	0.00069 J	0.0011	<0.001	<0.001	<0.001	<0.001
BW-202	9/21/04	0.0055	0.0046	<0.001	<0.001	<0.001	<0.001
DP-3-1	9/22/04	0.12	0.27	0.025	<0.0025	0.016	<0.0025
DP-3-1	12/14/04	0.016	0.046	0.31	<0.0025	0.014	<0.0025
DP-3-1 (DU-04401)	12/14,16/04	0.015	0.046	0.28	<0.002	0.013	<0.002
DP-3-2	9/30/04	0.087	0.16	0.0054	<0.001	0.0074	<0.001
MLW-1-1	9/15/04	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
MLW-1-1	12/14/04	<0.001	<0.001	<0.001	<0.001	<0.001	0.0007 J
MLW-1-2	9/15/04	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Table 2

Summary of Volatile Organic Compounds and Degradation Products in Groundwater

Medley Farm NPL Site

Station	Sample Date	Tetrachloroethene (mg/L)	Trichloroethene (mg/L)	cis-1,2-Dichloroethene (mg/L)	trans-1,2-Dichloroethene (mg/L)	1,1-Dichloroethene (mg/L)	Vinyl chloride (mg/L)
MLW-1-2	12/14/04	<0.001	<0.001	<0.001	<0.001	<0.001	0.00038 J
MLW-1-3	9/15/04	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
MLW-1-3	12/14/04	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
MLW-1-4	12/14/04	0.001	0.00089 J	<0.001	<0.001	<0.001	<0.001
MLW-3-1	9/16/04	0.0049	0.0054	<0.001	<0.001	<0.001	<0.001
MLW-3-1	12/14/04	0.0019	0.0044	0.0012	<0.001	<0.001	<0.001
MLW-3-2	9/16/04	0.0051	0.0056	<0.001	<0.001	<0.001	<0.001
MLW-3-2	12/14/04	0.0013	0.0019	<0.001	<0.001	<0.001	<0.001
MLW-3-3	9/15/04	0.0012	0.0019	<0.001	<0.001	<0.001	<0.001
MLW-3-3	12/14/04	0.0012	0.0015	<0.001	<0.001	<0.001	<0.001
MLW-3-4	12/14/04	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
MW-2-1	9/17/04	0.014	0.023	0.0042	<0.001	0.0058	<0.001
MW-2-1	12/20,21/04	0.0067	0.022	0.0018	<0.001	0.0079	<0.001
MW-2-2	9/17/04	0.019	0.04	0.0053	<0.001	0.0028	<0.001
MW-2-2	12/20,21/04	0.0098	0.035	0.0032	<0.001	0.0026	<0.001
MW-3D	9/20/04	0.078	0.13	0.015	<0.001	0.0048	<0.001
MW-3D	12/20/04	0.025	0.083	0.014	<0.001	0.0033	<0.001
MW-4-1	9/20/04	0.036	0.069	0.0037	<0.001	0.0024	<0.001
MW-4-1	12/17/04	0.026	0.06	<0.001	<0.001	0.002	<0.001
MW-4-2	9/20/04	0.12	0.17	0.004	<0.001	0.0018	<0.001
MW-4-2	12/17/04	0.055	0.091	0.018	<0.001	0.00081 J	<0.001
SW-101	9/14,15/04	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SW-101	12/17/04	<0.001	0.0005 J	<0.001	<0.001	<0.001	<0.001
SW-102	9/23/04	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SW-108	9/21/04	0.0056	0.0059	<0.001	<0.001	<0.001	<0.001
SW-201	9/21/04	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SW-202	9/21/04	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Table B-1
Summary of Groundwater Analytical Results
February/March 2006

PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		A-1 02/22/06	A-2 02/22/06	A-3 02/21/06	A-4 02/21/06	A-5 02/20/06
Volatile Organics						
Acetone	--	0.35 Mj	<0.005	<0.005	0.022	0.016 Mj
2-Butanone	--	1 Mj	<0.005	<0.005	0.033	0.022 Mj
Chloroform	--	<0.01 Muj	<0.001	<0.001	<0.001	<0.001 Muj
1,1-Dichloroethane	--	<0.01 Muj	<0.001	<0.001	<0.001	<0.001 Muj
1,2-Dichloroethane	0.005	<0.01 Muj	0.0015	0.0019	0.00053 J	<0.001 Muj
1,1-Dichloroethene	0.007	<0.01 Muj	<0.001	<0.001	<0.001	<0.001 Muj
cis -1,2-Dichloroethene	0.07	<0.01 Muj	0.0014	0.0025	0.0088	0.0015 Mj
trans-1,2-Dichloroethene	0.1	<0.01 Muj	<0.001	<0.001	<0.001	<0.001 Muj
Methylene chloride	0.005	<0.01 Muj	<0.001	<0.001	<0.001	<0.001 Muj
1,1,1-Trichloroethane	0.2	<0.01 Muj	<0.001	<0.001	<0.001	<0.001 Muj
Trichloroethene	0.005	<0.01 Muj	<0.001	0.0034	<0.001	0.00088 MJj
1,1,2-Trichloroethane	0.005	<0.01 Muj	<0.001	<0.001	<0.001	<0.001 Muj
Tetrachloroethene	0.005	<0.01 Muj	<0.001	0.00064 J	<0.001	<0.001 Muj
Vinyl chloride	0.002	<0.01 Muj	<0.001	0.0014	0.00063 J	<0.001 Muj
Volatile Fatty Acids						
Acetic acid	--	610	<1	4	190	860
Butyric acid	--	110	<1	<1	11	22
Lactic Acid	--	<25	<25	<25	<25	<25
Propionic acid	--	1600	0.37 J	1.7	230	980
Pyruvic Acid	--	0.84 J	<10	<10	<10	<10
Field Indicators						
pH (S.U.)	6.5-8.5[3]	7.18	7.75	7.5	5.12	7.01
Dissolved Oxygen (mg/l.)	--	7.15	10.73	2.02	14.55	0.62
ORP (mV)	--	-165	-145	-159	-168	-363
Conductance, specific (uS/cm)	--	6430	360	394	699	4520
Temperature (°C)	--	16.37	15.62	15.7	15.15	16.4
Wet Chemistry						
Alkalinity as CaCO3	--	3200	190	150	590	2700
Chloride	250[3]	82 CNI	8.0	6.4	19	68 CI
Sulfate	250[3]	2.9 NBI	2.7 BI	2.9 BI	5.1 I	12 I
Inorganics						
Iron, dissolved ferrous	0.3[3]	>10	1	5	4	0
Manganese, dissolved	0.05[3]	6.5 j	5.8	5.4	7.3	8.5 j

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PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		A-6 02/20/06	A-7 02/22/06	B-1 02/23/06	B-2 02/23/06	B-3 02/27/06
Volatile Organics						
Acetone	--	<0.005	<0.005	**0.028 Mj**	<0.005	<0.005 *
2-Butanone	--	<0.005	<0.005	**0.091 Mj**	<0.005	<0.005 &
Chloroform	--	<0.001	<0.001	<0.001 Muj	<0.001	<0.001
1,1-Dichloroethane	--	<0.001	<0.001	<0.001 Muj	**0.0012**	<0.001
1,2-Dichloroethane	0.005	<0.001	**0.00062 J**	**0.0004 MJj**	**0.0058**	**0.0034**
1,1-Dichloroethene	0.007	<0.001	**0.00082 J**	<0.001 Muj	<0.001	<0.001
cis -1,2-Dichloroethene	0.07	**0.008**	**0.0097**	<0.001 Muj	**0.017**	**0.01**
trans-1,2-Dichloroethene	0.1	<0.001	<0.001	<0.001 Muj	**0.001**	<0.001
Methylene chloride	0.005	<0.001	<0.001	<0.001 Muj	<0.001	<0.001
1,1,1-Trichloroethane	0.2	<0.001	<0.001	<0.001 Muj	<0.001	<0.001
Trichloroethene	0.005	<0.001	**0.0046**	**0.0011 Mj**	**0.0031**	<0.001
1,1,2-Trichloroethane	0.005	<0.001	<0.001	<0.001 Muj	<0.001	<0.001
Tetrachloroethene	0.005	<0.001	<0.001	<0.001 Muj	<0.001	<0.001
Vinyl chloride	0.002	<0.001	**0.00053 J**	<0.001 Muj	**0.014**	**0.0016**
Volatile Fatty Acids						
Acetic acid	--	<1	**0.39 J**	**1600**	<1	<1
Butyric acid	--	<1	<1	**230**	<1	<1
Lactic Acid	--	<25	<25	<25	<25	<25
Propionic acid	--	<1	**0.38 J**	**2100**	**0.62 J**	<1
Pyruvic Acid	--	<10	<10	<10	<10	<10
Field Indicators						
pH (S.U.)	6.5-8.5[3]	**6.29**	**6.25**	7.06	6.7	7.09
Dissolved Oxygen (mg/L)	--	1.72	1.36	2.73	2.31	13.49
ORP (mV)	--	-86	-102	-381	-139	-75
Conductance, specific (uS/cm)	--	230	179	8030	309	283
Temperature (°C)	--	14.62	14.06	16.44	15.55	17.8
Wet Chemistry						
Alkalinity as CaCO3	--	110	99	5800	160	110 I
Chloride	250[3]	5.5	5.1	130	7.5	<8.3 Au
Sulfate	250[3]	3.5 Bl	2.4 Bl	6.9	5.5	2.8 B
Inorganics						
Iron, dissolved ferrous	0.3[3]	**0.4**	**3**	0.1	**0.8**	**2**
Manganese, dissolved	0.05[3]	**0.49**	**1.2**	**2.9 j**	**4.2**	**1**

Table B-1
Summary of Groundwater Analytical Results
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PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		B-4 02/27/06	BW-108 03/03/06	BW-109 03/02/06	BW-2 02/28/06	BW-201 03/02/06
Volatile Organics						
Acetone	--	**0.035 M*j**	<0.005	<0.005	<0.005 *	<0.005
2-Butanone	--	**0.14 M&j**	<0.005 &	<0.005 &	<0.005 &	<0.005 &
Chloroform	--	<0.001 Muj	<0.001	<0.001	**0.002**	<0.001
1,1-Dichloroethane	--	<0.001 Muj	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.005	**0.00046 MJj**	<0.001	<0.001	**0.00039 J**	<0.001
1,1-Dichloroethene	0.007	<0.001 Muj	<0.001	<0.001	<0.001	<0.001
cis -1,2-Dichloroethene	0.07	**0.0029 Mj**	<0.001	<0.001	**0.0014**	<0.001
trans-1,2-Dichloroethene	0.1	<0.001 Muj	<0.001	<0.001	<0.001	<0.001
Methylene chloride	0.005	<0.001 Muj	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	0.2	<0.001 Muj	<0.001	<0.001	<0.001	<0.001
Trichloroethene	0.005	<0.001 Muj	**0.0012**	<0.001	**0.019**	**0.00049 J**
1,1,2-Trichloroethane	0.005	<0.001 Muj	<0.001	<0.001	<0.001	<0.001
Tetrachloroethene	0.005	<0.001 Muj	**0.00055 J**	<0.001	**0.0076**	<0.001
Vinyl chloride	0.002	**0.00047 MJj**	<0.001	<0.001	<0.001	<0.001
Volatile Fatty Acids						
Acetic acid	--	580	2	**0.69 J**	<1	<1
Butyric acid	--	55	<1	<1	<1	<1
Lactic Acid	--	<25	**4.4 J**	**5.5 J**	<25	<25
Propionic acid	-	**1100**	**0.29 J**	<1	<1	<1
Pyruvic Acid	--	**0.59 J**	<10	**0.63 J**	<10	<10
Field Indicators						
pH (S.U.)	6.5-8.5[3]	7.18	6.74	**5.94**	**6.22**	**6.01**
Dissolved Oxygen (mg/L)	--	7.86	10.31	15.44	9.9	5.29
ORP (mV)	--	-184	96	185	84	133
Conductance, specific (uS/cm)	--	3230	109	114	95	197
Temperature (°C)	--	20.2	12.88	17.53	17.64	19.6
Wet Chemistry						
Alkalinity as CaCO3	--	2000	39	50	27 I	55
Chloride	250[3]	35 A	4.2 B	4.6 B	<7.1 Au	5.3
Sulfate	250[3]	2.6 B	6.3	2.2 B	2.5 B	7.6
Inorganics						
Iron, dissolved ferrous	0.3[3]	**2**	NM	0	0	0
Manganese, dissolved	0.05[3]	**3.2**	0.021	0.013	0.019	0.0033 AB

Table B-1

Summary of Groundwater Analytical Results

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PARAMETER[1,2]	MCL[2]	LOCATION/SAMPLE DATE				
		BW-202 03/01/06	DP-3-1 02/27-28/06	DP-3-2 02/28/06	MLW-1-1 03/01/06	MLW-1-2 03/01/06
Volatile Organics						
Acetone	--	<0.005 *	<0.012 *	<0.005 *	0.003 *Jj	0.008 *j
2-Butanone	--	<0.005 &	<0.012 &	<0.005 &	0.007 &	0.0082 &
Chloroform	--	<0.001	0.01	0.00088 J	0.0026	0.0024
1,1-Dichloroethane	--	<0.001	0.0034	0.00094 J	<0.001	<0.001
1,2-Dichloroethane	0.005	<0.001	0.14	0.031	<0.001	<0.001
1,1-Dichloroethene	0.007	<0.001	<0.0025	<0.001	<0.001	<0.001
cis -1,2-Dichloroethene	0.07	<0.001	0.021	0.0036	<0.001	<0.001
trans-1,2-Dichloroethene	0.1	<0.001	0.0054	0.003	<0.001	<0.001
Methylene chloride	0.005	<0.001	<0.0025	<0.001	0.00075 J	0.0014
1,1,1-Trichloroethane	0.2	<0.001	<0.0025	<0.001	<0.001	<0.001
Trichloroethene	0.005	0.0014	0.021	0.0025	<0.001	<0.001
1,1,2-Trichloroethane	0.005	<0.001	0.033	0.021	<0.001	<0.001
Tetrachloroethene	0.005	0.0048	0.0022 J	<0.001	<0.001	<0.001
Vinyl chloride	0.002	<0.001	0.0078	0.00047 J	0.00022 J	0.00027 J
Volatile Fatty Acids						
Acetic acid	--	<1	0.53 J	<1	7.3	12
Butyric acid	--	<1	<1	<1	<1	0.31 J
Lactic Acid	--	<25	<25	<25	24 J	4.9 J
Propionic acid	--	<1	0.12 J	<1	0.66 J	3.1
Pyruvic Acid	--	<10	<10	<10	<10	<10
Field Indicators						
pH (S.U.)	6.5-8.5[3]	8.65	7.12	7.83	6.86	6.76
Dissolved Oxygen (mg/L)	--	7.13	14.71	12.4	9.2	4.76
ORP (mV)	--	109	-118	-184	10	9
Conductance, specific (uS/cm)	--	233	340	292	280	250
Temperature (°C)	--	19.08	15.39	18.52	16.8	19.35
Wet Chemistry						
Alkalinity as CaCO3	--	110 I	160 I	160 I	130 I	130 I
Chloride	250[3]	<7.5 Au	<13 Au	<12 Au	<4.7 AB u	<4.6 AB u
Sulfate	250[3]	6.5	6.2	4.8	2.8 B	<4.0
Inorganics						
Iron, dissolved ferrous	0.3[3]	0	0.2	0.2	0	0
Manganese, dissolved	0.05[3]	0.022	3.2	3.5	0.0733	0.08

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PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		MLW-1-3 03/1,2,3/06	MLW-1-4 03/01/06	MLW-3-1 03/01/06	MLW-3-2 03/01/06	MLW-3-3 03/01/06
Volatile Organics						
Acetone	--	0.056	<0.005 *	0.028 *j	<0.005 *	<0.005 *
2-Butanone	--	<0.005 &	<0.005 &	0.0064 &	<0.005 &	<0.005 &
Chloroform	--	0.0009 J	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethane	--	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethene	0.007	<0.001	<0.001	<0.001	<0.001	<0.001
cis -1,2-Dichloroethene	0.07	<0.001	<0.001	0.021	0.0077	0.0037
trans-1,2-Dichloroethene	0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Methylene chloride	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	0.2	<0.001	<0.001	<0.001	<0.001	<0.001
Trichloroethene	0.005	<0.001	0.0012	<0.001	0.0015	0.00065 J
1,1,2-Trichloroethane	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
Tetrachloroethene	0.005	<0.001	0.0012	<0.001	0.00056 J	<0.001
Vinyl chloride	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Volatile Fatty Acids						
Acetic acid	--	0.64 J	0.54 J	490	0.27 J	<1
Butyric acid	--	<1	<1	230	<1	<1
Lactic Acid	--	<25	<25	220	<25	<25
Propionic acid	--	<1	<1	50	<1	<1
Pyruvic Acid	--	<10	<10	<10	<10	<10
Field Indicators						
pH (S.U.)	6.5-8.5[3]	6.75	7.56	4.24	6.77	6.28
Dissolved Oxygen (mg/L)	--	4.5	10.37	9.59	9.83	4.19
ORP (mV)	--	62	25	177	50	161
Conductance, specific (uS/cm)	--	1160	510	535	190	164
Temperature (°C)	--	17.71	17.5	16.6	16.6	16.4
Wet Chemistry						
Alkalinity as CaCO3	--	370	250 NI	230 I	76 I	58 I
Chloride	250[3]	12	17 A	<6.0 Au	<4.4 AB u	<4.5 AB u
Sulfate	250[3]	150	11	27	2.9 B	2.5 B
Inorganics						
Iron, dissolved ferrous	0.3[3]	0	0	3	0	0
Manganese, dissolved	0.05[3]	0.01	0.0035 B	5.7	0.038	0.019

Table B-1
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PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		MLW-3-4 03/01/06	MW-2-1 03/01/06	MW-2-2 02/28/06	MW-3D 03/02/06	MW-4-1 02/24/06
Volatile Organics						
Acetone	--	<0.005 *	**0.0028 *Jj**	<0.005 *uj	**0.0054**	<0.005
2-Butanone	--	<0.005 &	<0.005 &	<0.005 &uj	**0.0066 &**	<0.005
Chloroform	--	<0.001	**0.0019**	**0.0045 j**	<0.001	**0.023**
1,1-Dichloroethane	--	<0.001	<0.001	<0.001 uj	<0.001	<0.001
1,2-Dichloroethane	0.005	<0.001	**0.0012**	**0.0005 Jj**	**0.002**	**0.00073 J**
1,1-Dichloroethene	0.007	<0.001	**0.0029**	**0.0012 j**	**0.0031**	**0.0016**
cis -1,2-Dichloroethene	0.07	**0.00095 J**	<0.001	**0.0043 j**	**0.097**	**0.0022**
trans-1,2-Dichloroethene	0.1	<0.001	<0.001	<0.001 uj	<0.001	<0.001
Methylene chloride	0.005	<0.001	<0.001	<0.001 uj	<0.001	<0.001
1,1,1-Trichloroethane	0.2	<0.001	<0.001	<0.001 uj	<0.001	<0.001
Trichloroethene	0.005	<0.001	**0.016**	**0.038 j**	**0.00058 J**	**0.058**
1,1,2-Trichloroethane	0.005	<0.001	<0.001	<0.001 uj	<0.001	**0.0047**
Tetrachloroethene	0.005	<0.001	**0.0052**	**0.018 j**	<0.001	**0.033**
Vinyl chloride	0.002	<0.001	<0.001	<0.001 uj	**0.00038 J**	<0.001
Volatile Fatty Acids						
Acetic acid	--	<1	<1	<1	**140**	<1
Butyric acid	--	<1	<1	<1	**7.1**	<1
Lactic Acid	--	<25	<25	<25	<25	<25
Propionic acid	--	<1	<1	<1	**180**	<1
Pyruvic Acid	--	<10	<10	<10	<10	<10
Field Indicators						
pH (S.U.)	6.5-8.5[3]	**5.9**	**10.09**	**6.1**	6.86	7.96
Dissolved Oxygen (mg/L)	--	6.69	7.73	3.72	0.91	7.15
ORP (mV)	--	132	92	83	-269	187
Conductance, specific (uS/cm)	--	248	377	180	1170	457
Temperature (°C)	--	15.4	19.7	20.8	17.24	21.9
Wet Chemistry						
Alkalinity as CaCO3	--	47 l	140 l	320 l	570	160
Chloride	250[3]	<4.1 AB u	<4.7 AB u	<5.9 Au	11	6.9
Sulfate	250[3]	2.4 B	13	6.3	4.4	5.8
Inorganics						
Iron, dissolved ferrous	0.3[3]	0	0	0	**1**	0
Manganese, dissolved	0.05[3]	0.037	0.022	0.025	**4.9**	0.014

Table B-1
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PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		MW-4-2 02/24/06	SW-101 02/24/06	SW-102 02/28/06	SW-108 02/23/06	SW-201 02/23/06
Volatile Organics						
Acetone	--	<0.0032 Ju	<0.005	<0.005 *	<0.005	<0.005
2-Butanone	--	<0.005	<0.005	<0.005 &	<0.005	<0.005
Chloroform	--	**0.018**	<0.001	<0.001	<0.001	**0.0043**
1,1-Dichloroethane	--	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.005	**0.0017**	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethene	0.007	<0.001	<0.001	<0.001	<0.001	<0.001
cis -1,2-Dichloroethene	0.07	**0.024**	<0.001	<0.001	<0.001	**0.00088 J**
trans-1,2-Dichloroethene	0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Methylene chloride	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	0.2	<0.001	<0.001	<0.001	<0.001	<0.001
Trichloroethene	0.005	**0.031**	<0.001	<0.001	**0.002**	**0.014**
1,1,2-Trichloroethane	0.005	**0.0092**	<0.001	<0.001	<0.001	<0.001
Tetrachloroethene	0.005	**0.0098**	<0.001	<0.001	**0.0019**	**0.0052**
Vinyl chloride	0.002	**0.00048 J**	<0.001	<0.001	<0.001	<0.001
Volatile Fatty Acids						
Acetic acid	--	<1	<1	<1	<1	<1
Butyric acid	--	<1	<1	<1	<1	<1
Lactic Acid	--	<25	<25	<25	**6.4 J**	<25
Propionic acid	--	<1	<1	<1	<1	<1
Pyruvic Acid	--	<10	<10	<10	<10	<10
Field Indicators						
pH (S.U.)	6.5-8.5[3]	7.18	6.7	6.55	**5.95**	**5.91**
Dissolved Oxygen (mg/L)	--	5.75	7.82	2.9	7.47	6.59
ORP (mV)	--	-58	187	117	306	305
Conductance, specific (uS/cm)	--	541	279	402	129	111
Temperature (°C)	--	20.8	16.5	19.8	14.4	16.6
Wet Chemistry						
Alkalinity as CaCO3	--	200	92	160	33	37
Chloride	250[3]	7.3	6.2	<5.8 Au	5.5	4.3 B
Sulfate	250[3]	3.7 B	6.0	3.6 B	3.8 B	2.3 B
Inorganics						
Iron, dissolved ferrous	0.3[3]	0.02	0	0	0	0
Manganese, dissolved	0.05[3]	**7.4**	0.011	0.011	0.019	0.01

Table B-1
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PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE		
		SW-202 03/01/06	SW-3 03/02/06	SW-4 03/01/06
Volatile Organics				
Acetone	--	<0.005 *	<0.01	<0.005 *
2-Butanone	--	<0.005 &	<0.01 &	<0.005 &
Chloroform	--	<0.001	<0.002	**0.011**
1,1-Dichloroethane	--	<0.001	<0.002	**0.0011**
1,2-Dichloroethane	0.005	<0.001	<0.002	**0.00053 J**
1,1-Dichloroethene	0.007	<0.001	<0.002	**0.022**
cis -1,2-Dichloroethene	0.07	<0.001	**0.0064**	<0.001
trans-1,2-Dichloroethene	0.1	<0.001	<0.002	<0.001
Methylene chloride	0.005	<0.001	<0.002	<0.001
1,1,1-Trichloroethane	0.2	<0.001	<0.002	**0.013**
Trichloroethene	0.005	<0.001	**0.16**	**0.045**
1,1,2-Trichloroethane	0.005	<0.001	<0.002	**0.0017**
Tetrachloroethene	0.005	<0.001	**0.3**	**0.0039**
Vinyl chloride	0.002	<0.001	<0.002	<0.001
Volatile Fatty Acids				
Acetic acid	--	<1	**0.47 J**	**0.27 J**
Butyric acid	--	<1	<1	<1
Lactic Acid	--	<25	<25	<25
Propionic acid	--	<1	<1	<1
Pyruvic Acid	--	<10	<10	<10
Field Indicators				
pH (S.U.)	6.5-8.5[3]	**5.44**	**6.08**	**5.54**
Dissolved Oxygen (mg/L)	--	5.16	8.85	8.66
ORP (mV)	--	163	168	181
Conductance, specific (uS/cm)	--	65	109	84
Temperature (°C)	--	19.04	21	19.98
Wet Chemistry				
Alkalinity as CaCO3	--	13 B	32	19 B
Chloride	250[3]	<5.5 Au	4.0 B	<9.9 AN u
Sulfate	250[3]	2.4 B	2.0 B	2.0 NB
Inorganics				
Iron, dissolved ferrous	0.3[3]	0	0	0
Manganese, dissolved	0.05[3]	0.038	0.012	0.044

Table B-1
Summary of Groundwater Analytical Results
February/March 2006

Qualifiers

(1) Analytical results are reported in milligrams per liter (mg/L) unless otherwise noted. Only parameters detected in at least one sample at a concentration above the laboratory reporting limit are included in this summary table.

(2) Maximum Contaminant Level (National Primary Drinking Water Standards); *Drinking Water Standards and Health Advisories* (USEPA, 2004)

(3) Secondary Maximum Contaminant Level (SMCL) (National Primary Drinking Water Standards); *Drinking Water Standards and Health Advisories* (USEPA, 2004)

< - Concentration less than the Quantitation Limit or not validated if accompanied by "u" qualifier.

A - Analyte detected in method blank.

B - The analyte has been detected between the method detection limit and the reporting limit.

C - Elevated detection limit due to matrix effects.

J - Concentration detected equal to or greater than the method detection limit but less than the reporting limit.

M - Sample pH was greater than 2.

N - Spiked sample recovery not within control limits.

* - Precision not within control limits.

& - Laboratory Control Spike recovery not within control limits.

j - Concentration considered an estimate based on data validation.

l - Analyte present; reported value may be biased low.

u - Laboratory reported detection not validated during data validation process.

uj - Not detected; quantitation limit may be inaccurate or imprecise.

NM - Not measured.

Bolding indicates sample detection.

Shading indicates sample exceeds MCL or SMCL.

Table B-1
Summary of Groundwater Analytical Results
September 2007

PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		A-1 09/24/07	A-2 09/20/07	A-3 09/19/07	A-4 09/20/07	A-5 09/21/07
Volatile Organics						
Acetone	--	<0.005	<0.005 *	<0.005 *	<0.005 *	<0.005 *
Benzene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
2-Butanone	--	<0.005	<0.005	<0.005	<0.005	<0.005
Chloroform	--	<0.001	**0.0015**	**0.0053**	<0.001	**0.0089**
1,1-Dichloroethane	--	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.005	**0.0033**	**0.00087 J**	**0.0014**	**0.0011**	**0.0013**
1,1-Dichloroethene	0.007	<0.001	<0.001	**0.0024**	<0.001	**0.004**
cis-1,2-Dichloroethene	0.07	**0.0047**	**0.0035**	**0.0099**	**0.0033**	**0.017**
trans-1,2-Dichloroethene	0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Methylene chloride	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	0.2	<0.001	<0.001	<0.001	<0.001	<0.001
Trichloroethene	0.005	**0.0041**	**0.02**	**0.031**	**0.0081**	**0.083**
1,1,2-Trichloroethane	0.005	<0.001	<0.001	**0.0025**	**0.0007 J**	**0.0016**
Tetrachloroethene	0.005	**0.00089 J**	**0.0095**	**0.019**	**0.0042**	**0.038**
Vinyl chloride	0.002	**0.006**	**0.0032**	**0.00071 J**	**0.00067 J**	**0.0015**
Volatile Fatty Acids						
Acetic acid	--	<1	<1	<1	<1	<1
Propionic acid	--	<1	<1	<1	<1	<1
Field Indicators						
pH (S.U.)	6.5-8.5[3]	7.09	**6.46**	**6.11**	**6.21**	**6.1**
Dissolved Oxygen (mg/L)	--	0.64	0.81	1.25	0.22	1.97
ORP (mV)	--	-64.6	-163.8	-75.4	-163.3	-81.2
Conductance, specific (uS/c	--	359	196	139	166	139
Temperature (°C)	--	18.37	17.43	17	16.11	17.34
Wet Chemistry						
Sulfate	250[3]	4.8 j-	4.1 j-	3.7 NBj-	4.2 j-	4.6 j-
Inorganics						
Iron, dissolved ferrous	0.3[3]	**0.8**	**0.4**	0	**0.4**	0
Manganese, dissolved	0.05[3]	**4.3**	**5.8**	**0.14**	**3.2**	**0.29**

Table B-1
Summary of Groundwater Analytical Results
September 2007

PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		A-6 09/21/07	A-7 09/20/07	B-1 09/24/07	(DU-07301) B-1 09/24/07	B-2 09/24/07
Volatile Organics						
Acetone	--	<0.005 *	**0.0076 ***	<0.005	<0.005	<0.005
Benzene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
2-Butanone	--	<0.005	<0.005	<0.005	<0.005	<0.005
Chloroform	--	<0.001	<0.001	**0.001**	**0.0011**	**0.0034**
1,1-Dichloroethane	--	<0.001	<0.001	<0.001	<0.001	**0.0024**
1,2-Dichloroethane	0.005	**0.0008 J**	**0.0012**	**0.00069 J**	**0.00065 J**	**0.0016**
1,1-Dichloroethene	0.007	**0.0011**	<0.001	**0.0017**	**0.0016**	**0.015**
cis-1,2-Dichloroethene	0.07	**0.02**	**0.0058**	**0.0048**	**0.0046**	**0.045**
trans-1,2-Dichloroethene	0.1	<0.001	<0.001	<0.001	<0.001	**0.0021**
Methylene chloride	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	0.2	<0.001	<0.001	<0.001	<0.001	**0.0018**
Trichloroethene	0.005	**0.0031**	**0.0036**	**0.011**	**0.011**	**0.14**
1,1,2-Trichloroethane	0.005	<0.001	<0.001	<0.001	<0.001	**0.0042**
Tetrachloroethene	0.005	<0.001	**0.00097 J**	**0.0038**	**0.0037**	**0.022**
Vinyl chloride	0.002	**0.0075**	**0.003**	**0.00043 J**	**0.00038 J**	**0.0017**
Volatile Fatty Acids						
Acetic acid	--	<1	<1	<1	<1	<1
Propionic acid	--	<1	<1	<1	<1	<1
Field Indicators						
pH (S.U.)	6.5-8.5[3]	**6.47**	**6.49**	**6.14**	NM	**6.36**
Dissolved Oxygen (mg/L)	--	0.2	0.08	2.22	NM	1.13
ORP (mV)	--	11	-191.1	33.1	NM	88.4
Conductance, specific (uS/c	--	191	201	169	NM	181
Temperature (°C)	--	17.22	16.77	18.37	NM	17.59
Wet Chemistry						
Sulfate	250[3]	4.5 Nj-	5.3 j-	2.8 Bj-	2.8 Bj-	4.0 Bj-
Inorganics						
Iron, dissolved ferrous	0.3[3]	0.2	**0.8**	0.1	NM	0
Manganese, dissolved	0.05[3]	**3.1**	**4.3**	**1.6**	**1.6**	**0.42**

Table B-1
Summary of Groundwater Analytical Results
September 2007

PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		B-3 09/25/07	B-4 09/25/07	BW-1 09/28/07	BW-105 09/26/07	BW-106 09/27/07
Volatile Organics						
Acetone	–	<0.01	<0.005	<0.005	<0.005	<0.005
Benzene	0.005	<0.002	<0.001	<0.001	<0.001	<0.001
2-Butanone	–	<0.01	<0.005	<0.005	<0.005	<0.005
Chloroform	–	**0.00085 J**	<0.001	<0.001	**0.00091 J**	<0.001
1,1-Dichloroethane	–	**0.0043**	**0.0097**	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.005	**0.13**	**0.0029**	<0.001	<0.001	<0.001
1,1-Dichloroethene	0.007	**0.0045**	**0.0042**	<0.001	**0.00075 J**	<0.001
cis-1,2-Dichloroethene	0.07	**0.2**	**0.0045**	<0.001	<0.001	<0.001
trans-1,2-Dichloroethene	0.1	**0.0099**	**0.00092 J**	<0.001	<0.001	<0.001
Methylene chloride	0.005	<0.002	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	0.2	**0.0025**	<0.001	<0.001	<0.001	<0.001
Trichloroethene	0.005	**0.035**	**0.0036**	<0.001	<0.001	<0.001
1,1,2-Trichloroethane	0.005	**0.009**	<0.001	<0.001	<0.001	<0.001
Tetrachloroethene	0.005	**0.0024**	<0.001	<0.001	<0.001	<0.001
Vinyl chloride	0.002	**0.1**	**0.013**	<0.001	<0.001	<0.001
Volatile Fatty Acids						
Acetic acid	–	<1	<1	<1	<1	<1
Propionic acid	–	<1	<1	<1	<1	<1
Field Indicators						
pH (S.U.)	6.5-8.5[3]	6.95	6.55	**6.21**	**6.22**	**6.32**
Dissolved Oxygen (mg/L)	–	0.23	2.64	8.50	7.71	5.77
ORP (mV)	–	-207.9	-66	50.7	118.2	-23.5
Conductance, specific (uS/c	–	264	188	94	116	120
Temperature (°C)	–	18.5	17.93	17.71	19.15	16.04
Wet Chemistry						
Sulfate	250[3]	5.1 j-	2.2 Bj-	1.7 Bj-	<4.0 uj	2.6 Bj-
Inorganics						
Iron, dissolved ferrous	0.3[3]	0.1	**2**	0	0	0
Manganese, dissolved	0.05[3]	**2.8**	**2.8**	<0.00032 AB u	0.0042 A	<0.00025 AB u

Table B-1
Summary of Groundwater Analytical Results
September 2007

PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		BW-108 09/27/07	(DU-07303) BW-108 09/27/07	BW-109 09/26/07	BW-110 09/26/07	BW-2 09/26/07
Volatile Organics						
Acetone	–	<0.005	<0.005	<0.005	<0.005	<0.005
Benzene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
2-Butanone	–	<0.005	<0.005	<0.005	<0.005	<0.02
Chloroform	–	<0.001	<0.001	<0.001	**0.00039 J**	**0.001**
1,1-Dichloroethane	–	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethene	0.007	<0.001	<0.001	<0.001	<0.001	<0.001
cis-1,2-Dichloroethene	0.07	**0.0039**	**0.0037**	<0.001	<0.001	**0.002**
trans-1,2-Dichloroethene	0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Methylene chloride	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	0.2	<0.001	<0.001	<0.001	<0.001	<0.001
Trichloroethene	0.005	**0.0073**	**0.0069**	<0.001	**0.00082 J**	**0.017**
1,1,2-Trichloroethane	0.005	<0.001	<0.001	<0.001	<0.001	**0.00048 J**
Tetrachloroethene	0.005	**0.0031**	**0.0029**	<0.001	<0.001	**0.0065**
Vinyl chloride	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Volatile Fatty Acids						
Acetic acid	–	<1	<1	<1	<1	<1
Propionic acid	–	<1	<1	<1	<1	<1
Field Indicators						
pH (S.U.)	6.5-8.5[3]	**6.48**	NM	**6.15**	7.01	**6.05**
Dissolved Oxygen (mg/L)	–	0.98	NM	7.30	7.39	7.69
ORP (mV)	–	-146.2	NM	-18.1	98.1	42.3
Conductance, specific (uS/c	–	177	NM	95	251	99
Temperature (°C)	–	16.4	NM	17.12	18.62	19.34
Wet Chemistry						
Sulfate	250[3]	4.0 Bj-	4.1 j-	1.7 Bj-	10 j-	2.0 Bj-
Inorganics						
Iron, dissolved ferrous	0.3[3]	0	NM	0	0	0
Manganese, dissolved	0.05[3]	**0.27**	**0.28**	<0.001 Au	0.021	0.0043 A

Table B-1
Summary of Groundwater Analytical Results
September 2007

PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		BW-201 09/21/07	BW-202 09/24/07	BW-3 09/26/07	BW-4 09/26/07	DP-2-1 09/26/07
Volatile Organics						
Acetone	–	**0.0035 J**	**0.0066**	<0.005	<0.005	<0.005
Benzene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
2-Butanone	–	<0.005	<0.005	<0.005	<0.005	<0.005
Chloroform	–	<0.001	<0.001	<0.001	<0.001	**0.0024**
1,1-Dichloroethane	–	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.005	<0.001	<0.001	<0.001	<0.001	**0.0097**
1,1-Dichloroethene	0.007	<0.001	<0.001	<0.001	<0.001	**0.00059 J**
cis-1,2-Dichloroethene	0.07	<0.001	<0.001	<0.001	<0.001	**0.079**
trans-1,2-Dichloroethene	0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Methylene chloride	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	0.2	<0.001	<0.001	<0.001	<0.001	<0.001
Trichloroethene	0.005	**0.00063 J**	**0.0038**	<0.001	<0.001	**0.047**
1,1,2-Trichloroethane	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
Tetrachloroethene	0.005	<0.001	**0.0068**	<0.001	<0.001	**0.061**
Vinyl chloride	0.002	<0.001	<0.001	<0.001	<0.001	**0.0084**
Volatile Fatty Acids						
Acetic acid	–	<1	<1	<1	<1	<1
Propionic acid	–	<1	<1	<1	<1	<1
Field Indicators						
pH (S.U.)	6.5-8.5[3]	**5.86**	**9.04**	**6.27**	6.88	**6.36**
Dissolved Oxygen (mg/L)	–	0.13	5.86	2.70	2.23	0.31
ORP (mV)	–	-91.8	-114.6	-9.2	-3.5	-89.3
Conductance, specific (uS/c	–	175	194	173	290	206
Temperature (°C)	–	16.77	18.69	16.43	15.61	18.03
Wet Chemistry						
Sulfate	250[3]	6.8 j-	5.8 j-	5.2 j-	8.0 j-	5.2 j-
Inorganics						
Iron, dissolved ferrous	0.3[3]	0	**0.5**	0	0	**2**
Manganese, dissolved	0.05[3]	0.01 A	0.0048 A	0.0039 A	<0.00089 AB u	**2.5**

Table B-1
Summary of Groundwater Analytical Results
September 2007

PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		DP-3-1 09/25/07	(DU-07302) DP-3-1 09/26/07	DP-3-2 09/25/07	MLW-1-1 09/27/07	MLW-1-2 09/27/07
Volatile Organics						
Acetone	–	<0.012	<0.005	<0.025	**0.0061**	**0.0083**
Benzene	0.005	<0.0025	**0.0005 J**	<0.005	<0.001	<0.001
2-Butanone	–	<0.012	<0.005	<0.025	**0.011**	**0.0098**
Chloroform	–	<0.0025	**0.00044 J**	<0.005	**0.002**	**0.0015**
1,1-Dichloroethane	–	**0.005**	**0.005**	**0.004 J**	<0.001	<0.001
1,2-Dichloroethane	0.005	**0.11**	**0.11**	**0.45**	<0.001	<0.001
1,1-Dichloroethene	0.007	<0.0025	**0.0011**	<0.005	<0.001	<0.001
cis-1,2-Dichloroethene	0.07	**0.12**	**0.13**	**0.28**	<0.001	<0.001
trans-1,2-Dichloroethene	0.1	**0.0075**	**0.0067**	**0.015**	<0.001	<0.001
Methylene chloride	0.005	<0.0025	<0.001	<0.005	**0.0011**	**0.00082 J**
1,1,1-Trichloroethane	0.2	<0.0025	**0.0013**	<0.005	<0.001	<0.001
Trichloroethene	0.005	**0.0025**	**0.0027**	**0.0037 J**	<0.001	<0.001
1,1,2-Trichloroethane	0.005	**0.017**	**0.017**	**0.013**	<0.001	<0.001
Tetrachloroethene	0.005	<0.0025	**0.00068 J**	<0.005	<0.001	<0.001
Vinyl chloride	0.002	**0.1**	**0.1**	**0.18**	**0.00023 J**	<0.001
Volatile Fatty Acids						
Acetic acid	–	<1	<1	<1	<1	**12**
Propionic acid	–	<1	<1	<1	<1	**3.1**
Field Indicators						
pH (S.U.)	6.5-8.5[3]	6.86	NM	6.71	6.51	8.37
Dissolved Oxygen (mg/L)	–	0.38	NM	0.19	NM	NM
ORP (mV)	–	-138.5	NM	-203.4	NM	NM
Conductance, specific (uS/c	–	226	NM	226	306	321
Temperature (°C)	–	18.72	NM	18.94	19.2	18.7
Wet Chemistry						
Sulfate	250[3]	5.0 j-	5.0 j-	5.1 j-	<4.0 uj	<4.0 uj
Inorganics						
Iron, dissolved ferrous	0.3[3]	**0.8**	NM	**1**	0	0.1
Manganese, dissolved	0.05[3]	**3.2**	**3.1**	**3.2**	0.05	**0.056 E**

Table B-1
Summary of Groundwater Analytical Results
September 2007

PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		MLW-1-3 09/27/07	MLW-1-4 09/27/07	MLW-3-2 09/27/07	MLW-3-3 09/27/07	MLW-3-4 09/27/07
Volatile Organics						
Acetone	–	**0.05**	<0.005	<0.005	<0.005	<0.005
Benzene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
2-Butanone	–	<0.005	<0.005	<0.005	<0.005	<0.005
Chloroform	–	**0.0021**	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethane	–	**0.00076 J**	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethene	0.007	<0.001	<0.001	<0.001	<0.001	<0.001
cis-1,2-Dichloroethene	0.07	<0.001	<0.001	**0.018**	**0.028**	**0.01**
trans-1,2-Dichloroethene	0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Methylene chloride	0.005	**0.00074 J**	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	0.2	<0.001	<0.001	<0.001	<0.001	<0.001
Trichloroethene	0.005	<0.001	**0.00071 J**	<0.001	<0.001	<0.001
1,1,2-Trichloroethane	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
Tetrachloroethene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
Vinyl chloride	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Volatile Fatty Acids						
Acetic acid	–	<1	<1	<1	<1	<1
Propionic acid	–	<1	<1	<1	<1	<1
Field Indicators						
pH (S.U.)	6.5-8.5[3]	**10.1**	6.98	6.82	**6.4**	**6.49**
Dissolved Oxygen (mg/L)	–	NM	NM	NM	NM	NM
ORP (mV)	–	NM	NM	NM	NM	NM
Conductance, specific (uS/c	–	1142	560	176.8	137.9	89.8
Temperature (°C)	–	18.3	18	20.6	22	20.5
Wet Chemistry						
Sulfate	250[3]	160 j-	12 j-	NM	1.8 Bj-	1.8 Bj-
Inorganics						
Iron, dissolved ferrous	0.3[3]	NM	NM	NM	0	0
Manganese, dissolved	0.05[3]	NM	NM	NM	0.002 A	0.0066

Table B-1
Summary of Groundwater Analytical Results
September 2007

PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		MW-2-1 09/21/07	MW-2-2 09/21/07	MW-3D 09/24/07	MW-4-1 09/24/07	MW-4-2 09/24/07
Volatile Organics						
Acetone	–	<0.005 *	<0.005 *	<0.005	<0.005	<0.005
Benzene	0.005	<0.001	<0.001	**0.00041 J**	<0.001	<0.001
2-Butanone	–	<0.005	<0.005	<0.005	<0.005	<0.005
Chloroform	–	<0.001	**0.0043**	**0.00079 J**	<0.001	<0.001
1,1-Dichloroethane	–	<0.001	<0.001	**0.0022**	<0.001	<0.001
1,2-Dichloroethane	0.005	**0.00081 J**	**0.00082 J**	**0.0048**	**0.00054 J**	**0.002**
1,1-Dichloroethene	0.007	<0.001	**0.0023**	**0.0032**	<0.001	<0.001
cis-1,2-Dichloroethene	0.07	<0.001	**0.0098**	**0.1**	<0.001	**0.001**
trans-1,2-Dichloroethene	0.1	<0.001	<0.001	**0.0059**	<0.001	<0.001
Methylene chloride	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	0.2	<0.001	<0.001	<0.001	<0.001	<0.001
Trichloroethene	0.005	<0.001	**0.042**	**0.094**	<0.001	**0.00079 J**
1,1,2-Trichloroethane	0.005	<0.001	**0.00074 J**	**0.0079**	<0.001	<0.001
Tetrachloroethene	0.005	<0.001	**0.017**	**0.011**	<0.001	<0.001
Vinyl chloride	0.002	<0.001	**0.0014**	**0.09**	**0.00099 J**	**0.0063**
Volatile Fatty Acids						
Acetic acid	–	<1	<1	<1	<1	<1
Propionic acid	–	<1	<1	<1	<1	<1
Field Indicators						
pH (S.U.)	6.5-8.5[3]	7.11	**6.45**	6.97	7.01	6.73
Dissolved Oxygen (mg/L)	–	0.11	0.21	0.15	0.10	0.25
ORP (mV)	–	-210.1	-158.2	-290.7	-291.5	-190.9
Conductance, specific (uS/c	–	1526	222	291	1491	338
Temperature (°C)	–	18.94	18.61	18.37	20.39	18.65
Wet Chemistry						
Sulfate	250[3]	4.2 j-	7.5 j-	4.3 j-	17 j-	3.9 Bj-
Inorganics						
Iron, dissolved ferrous	0.3[3]	**2**	**4**	0.3	0.3	**0.4**
Manganese, dissolved	0.05[3]	**0.26**	**2**	**3.4**	**0.52**	**4.7**

Table B-1
Summary of Groundwater Analytical Results
September 2007

PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		SW-1 09/28/07	SW-101 09/19/07	SW-102 09/19/07	SW-103 09/20/07	SW-104 09/20/07
Volatile Organics						
Acetone	–	<0.005	<0.005 *	<0.005 *	<0.005 *	<0.005 *
Benzene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
2-Butanone	–	<0.005	<0.005	<0.005	<0.005	<0.005
Chloroform	–	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethane	–	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethene	0.007	<0.001	<0.001	<0.001	<0.001	<0.001
cis-1,2-Dichloroethene	0.07	<0.001	<0.001	<0.001	<0.001	<0.001
trans-1,2-Dichloroethene	0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Methylene chloride	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	0.2	<0.001	<0.001	<0.001	<0.001	<0.001
Trichloroethene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,2-Trichloroethane	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
Tetrachloroethene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
Vinyl chloride	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Volatile Fatty Acids						
Acetic acid	–	<1	<1	<1	<1	<1
Propionic acid	–	<1	<1	<1	<1	<1
Field Indicators						
pH (S.U.)	6.5-8.5[3]	**6.13**	**6.35**	**6.24**	**5.83**	**5.99**
Dissolved Oxygen (mg/L)	–	NM	NM	NM	NM	NM
ORP (mV)	–	NM	NM	NM	NM	NM
Conductance, specific (uS/c	–	80.3	213	281	80	79.8
Temperature (°C)	–	17	16.2	16.2	17.3	16.3
Wet Chemistry						
Sulfate	250[3]	<4.0 uj	5.6 j-	4.0 j-	<4.0	1.8 Bj-
Inorganics						
Iron, dissolved ferrous	0.3[3]	0	0	0	0	0
Manganese, dissolved	0.05[3]	0.0019 A	0.0074 A	<0.00081 AB u	<0.0025 Au	<0.0023 Au

Table B-1
Summary of Groundwater Analytical Results
September 2007

PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE				
		SW-106 09/20/07	SW-108 09/19/07	SW-109 09/20/07	SW-201 09/19/07	SW-202 09/19/07
Volatile Organics						
Acetone	–	**0.0025 *J**	**0.0045 *J**	<0.005 *	<0.005 *	<0.005 *
Benzene	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
2-Butanone	–	<0.005	<0.005	<0.005	<0.005	<0.005
Chloroform	–	<0.001	**0.0013**	<0.001	**0.0018**	<0.001
1,1-Dichloroethane	–	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethene	0.007	<0.001	<0.001	<0.001	<0.001	<0.001
cis-1,2-Dichloroethene	0.07	<0.001	<0.001	<0.001	<0.001	<0.001
trans-1,2-Dichloroethene	0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Methylene chloride	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	0.2	<0.001	<0.001	<0.001	<0.001	<0.001
Trichloroethene	0.005	<0.001	**0.013**	<0.001	**0.0058**	<0.001
1,1,2-Trichloroethane	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
Tetrachloroethene	0.005	<0.001	**0.012**	<0.001	**0.0026**	**0.00096 J**
Vinyl chloride	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Volatile Fatty Acids						
Acetic acid	–	<1	<1	<1	<1	<1
Propionic acid	–	<1	<1	<1	<1	<1
Field Indicators						
pH (S.U.)	6.5-8.5[3]	**6.07**	**6.24**	**6.23**	**6.04**	**5.86**
Dissolved Oxygen (mg/L)	–	NM	NM	NM	NM	NM
ORP (mV)	–	NM	NM	NM	NM	NM
Conductance, specific (uS/c	–	166.1	145.4	91.7	117.1	71.3
Temperature (°C)	–	15.7	16.7	17.4	17.3	15
Wet Chemistry						
Sulfate	250[3]	7.0 j-	5.3 j-	1.7 Bj-	1.8 Bj-	2.4 Bj-
Inorganics						
Iron, dissolved ferrous	0.3[3]	0	0	0	0	0
Manganese, dissolved	0.05[3]	**0.88**	**0.086**	0.011 A	0.013	**0.42**

Table B-1
Summary of Groundwater Analytical Results
September 2007

PARAMETER[1]	MCL[2]	LOCATION/SAMPLE DATE	
		SW-3 09/20/07	SW-4 09/20/07
Volatile Organics			
Acetone	–	<0.005 *	<0.005 *
Benzene	0.005	<0.001	<0.001
2-Butanone	–	<0.005	<0.005
Chloroform	–	<0.001	**0.01**
1,1-Dichloroethane	–	<0.001	**0.00098 J**
1,2-Dichloroethane	0.005	<0.001	<0.001
1,1-Dichloroethene	0.007	**0.00079 J**	**0.015**
cis-1,2-Dichloroethene	0.07	**0.063**	<0.001
trans-1,2-Dichloroethene	0.1	<0.001	<0.001
Methylene chloride	0.005	<0.001	<0.001
1,1,1-Trichloroethane	0.2	<0.001	**0.0082**
Trichloroethene	0.005	**0.13**	**0.036**
1,1,2-Trichloroethane	0.005	<0.001	**0.0012**
Tetrachloroethene	0.005	**0.092**	**0.0033**
Vinyl chloride	0.002	**0.029**	<0.001
Volatile Fatty Acids			
Acetic acid	–	<1	<1
Propionic acid	–	<1	<1
Field Indicators			
pH (S.U.)	6.5-8.5[3]	6.67	**6.02**
Dissolved Oxygen (mg/L)	–	NM	NM
ORP (mV)	–	NM	NM
Conductance, specific (uS/c	–	178.9	103
Temperature (°C)	–	16.4	17.3
Wet Chemistry			
Sulfate	250[3]	4.4 j-	1.9 Bj-
Inorganics			
Iron, dissolved ferrous	0.3[3]	**1.5**	0.1
Manganese, dissolved	0.05[3]	**2.1**	**0.19**

Table B-1
Summary of Groundwater Analytical Results
September 2007

Qualifiers

[1] Analytical results are reported in milligrams per liter (mg/L) unless otherwise noted. Only parameters detected in at least one sample at a concentration above the laboratory reporting limit are included in this summary table.

[2] Maximum Contaminant Level (National Primary Drinking Water Standards); *Drinking Water Standards and Health Advisories* (USEPA, 2004)

[3] Secondary Maximum Contaminant Level (SMCL) (National Primary Drinking Water Standards); *Drinking Water Standards and Health Advisories* (USEPA, 2004)

< - Concentration less than the Quantitation Limit or not validated if accompanied by "u" qualifier.

A - Analyte detected in method blank.

B - The analyte has been detected between the method detection limit and the reporting limit.

E - Estimated concentration due to matrix interferences.

J - Concentration detected equal to or greater than the method detection limit but less than the reporting limit.

N - Spiked sample recovery not within control limits.

* - Precision not within control limits.

j- - Concentration considered an estimate biased low based on data validation.

u - Laboratory reported detection not validated during data validation process.

uj - Not detected; quantitation limit may be inaccurate or imprecise.

NM - Not measured.

Bolding indicates sample detection.

Shading indicates sample exceeds MCL or SMCL.

Table 3
Summary of Groundwater Analytical Results - January/February 2009
Medley Farm NPL Site, Gaffney, South Carolina

PARAMETER[1]	A-2 01/30/09	A-3 02/04/09	A-4 02/05/09	A-5 02/05/09	A-6 02/06/09	(DU-09102) A-7 02/06/09	A-7 02/05/09	B-1 01/21/09	B-2 01/22/09	B-3 01/22/09	B-4 01/22/09	BW-1 02/06/09	BW-105 01/27/09	(DU-09101) BW-106 01/28/09	BW-106 01/28/09
Volatile Organic Compounds															
1,1,1-TCA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,2-TCA	<0.001	**0.002**	<0.001	**0.0015**	<0.001	<0.001	<0.001	<0.001	**0.0065**	**0.0156**	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-DCA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.00083J**	**0.0025**	**0.0032**	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-DCE	<0.001	**0.0027**	<0.001	**0.0031**	**0.00063J**	<0.001	<0.001	<0.001	**0.0013**	**0.0011**	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-DCA	**0.0021**	**0.0015**	**0.00094J**	**0.0042**	**0.0018**	**0.00054J**	**0.00055J**	**0.0026**	**0.0417**	**0.277**	<0.001	<0.001	<0.001	<0.001	<0.001
2-Butanone	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02L1	<0.02L1	<0.02L1	<0.02L1	<0.02	<0.02L1	<0.02L1	<0.02L1
Acetone	<0.02	<0.02	<0.02L1	<0.02L1	<0.02L1	<0.02L1	<0.02L1	<0.02L1	<0.02L1	<0.02L1	<0.02L1	<0.02L1	<0.02L1	<0.02L1	<0.02L1
Benzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloroethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloroform	<0.005	**0.004J**	<0.005	**0.0034J**	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chloromethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
cis-1,2-DCE	**0.0056**	**0.0115**	**0.0041**	**0.0463**	**0.0239**	**0.0032**	**0.003**	**0.0113**	**0.0498**	**0.134**	**0.001**	<0.001	<0.001	<0.001	<0.001
Methylene chloride	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCE	<0.001	**0.0168**	<0.001	**0.0173**	<0.001	<0.001	<0.001	**0.00045J**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
trans-1,2-DCE	<0.001	<0.001	<0.001	**0.00091J**	<0.001	<0.001	<0.001	<0.001	**0.0022**	**0.0068**	<0.001	<0.001	<0.001	<0.001	<0.001
TCE	**0.0017**	**0.0376**	**0.0016**	**0.0571**	**0.0017**	**0.00065J**	**0.0005J**	**0.0021**	<0.001	<0.001	<0.001	<0.001	<0.001	**0.00048J**	<0.001
Vinyl chloride	**0.0087**	<0.001	**0.0017**	**0.0132**	**0.0149**	**0.0015**	**0.0014**	**0.0078**	**0.0401**	**0.195**	**0.00094J**	<0.001	<0.001	<0.001	<0.001
Wet Chemistry															
Sulfate	**5.4**	**4.2**	**4.5**	**5.6**	**5.3**	**5.2**	**5.1**	**4.2**	**7.0**	**5.2**	**3.2J**	**1.4J**	**1.4J**	**2.5J**	**2.5J**
Metals															
Manganese, dissolved	**6.03**	**0.4**	**2.61**	**1.3**	**3.17**	**2.92**	**2.93**	**5.76**	**4.37**	**3.64**	**1.76**	<0.00082BJ u	**0.0048J**	**0.00089J**	<0.005
Volatile Fatty Acids															
Acetic acid	<1	<2.2u	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Butyric acid	<1	<1	<0.3Ju	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Lactic Acid	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Propionic acid	<1	<0.2Ju	<1	<1	<0.7Ju	<1	<1	<1	<1	<1	<1	<0.8Ju	<1	<1	<1
Pyruvic Acid	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Field Parameters															
Conductance, specific (µS/cm)	300	157	193	167	216	NA	224	231	298	324	132	97	117	NA	119
DO (mg/L)	0.63	1.16	0.47	0.65	0.51	NA	0.84	0.64	0.44	0.28	0.49	6.74	4.61	NA	4.82
Ferrous iron, dissolved (ppm)	0.8	0	1.0	0.8	0.9	NA	0.9	1.5	1.0	0.2	1.5	0	0	NA	0
ORP (mV)	-37.2	110.1	29.0	44.7	44.0	NA	-4.9	-129.1	-161.4	-105.0	-30.3	106.2	86.5	NA	197.2
pH (s.u.)	7.02	6.61	6.83	6.90	6.79	NA	7.24	6.70	7.03	7.20	6.55	6.48	6.23	NA	6.38
Temperature (°C)	16.66	16.38	16.16	16.60	16.57	NA	16.80	16.91	17.91	18.25	17.25	17.75	18.99	NA	15.81

[1] Analytical results are reported in milligrams per liter (mg/L) unless otherwise noted.

[2] Concentration is anomalous

B (Inorganic) The analyte has been detected between the method detection limit and the reporting limit.

j Concentration considered an estimate based on data validation.

J Estimated concentration.

MO Matrix spike recovery was outside laboratory control limits.

NA Not analyzed.

< *Concentration less than the Quantitation Limit or not validated if accompanied by "u" qualifier.*

Bolding indicates constituent detection.

I:\WpGVL\PJT\00-71243\57\007124357-004.XLS

Table 3
Summary of Groundwater Analytical Results - January/February 2009
Medley Farm NPL Site, Gaffney, South Carolina

PARAMETER[1]	BW-108 02/04/9	BW-109 01/28/09	BW-110 02/04/09	BW-2 01/27/09	BW-201 02/03/09	BW-202 01/30/09	BW-3 01/27/09	BW-4 01/27/09	DP-2-1 01/27/09	DP-3-1 01/29/09	DP-3-2 01/29/09	MLW-1-4 01/23/09	MLW-3-3 01/23/09	MLW-3-4 01/23/09	MW-2-1 02/03/09
Volatile Organic Compounds															
1,1,1-TCA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0025	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001
1,1,2-TCA	<0.001	<0.001	<0.001	**0.00082J**	<0.001	<0.001	<0.001	<0.001	<0.0025	<0.001	**0.0109**	<0.001	<0.001	<0.001	<0.001
1,1-DCA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0025	**0.0016**	**0.0018J**	<0.001	**0.00078J**	<0.001	<0.001
1,1-DCE	<0.001	<0.001	<0.001	**0.00058J**	<0.001	<0.001	<0.001	<0.001	<0.0025	<0.001	**0.0011J**	<0.001	<0.001	<0.001	**0.00092J**
1,2-DCA	<0.001	<0.001	<0.001	**0.00041J**	<0.001	<0.001	<0.001	<0.001	**0.0024J**	**0.00057J**	**0.286**	<0.001	<0.001	<0.001	<0.001
2-Butanone	<0.02	<0.02L1	<0.02	<0.02L1	<0.02	<0.02	<0.02L1	<0.02L1	<0.05L1	<0.02L1	<0.04L1	<0.02L1	<0.02L1	<0.02L1	<0.02
Acetone	<0.02	<0.02L1	<0.02	<0.02L1	<0.02	<0.02	<0.02L1	<0.02L1	<0.05L1	<0.02L1	<0.04L1	<0.02L1	<0.02L1	<0.02L1	<0.02
Benzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.0034**	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001
Chloroethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0025	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001
Chloroform	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0125	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005
Chloromethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0025	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001
cis-1,2-DCE	<0.001	<0.001	<0.001	**0.0042**	<0.001	<0.001	<0.001	<0.001	**0.099**	**0.0022**	**0.215**	<0.001	**0.0349**	<0.001	**0.003**
Methylene chloride	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0025	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001
PCE	**0.0018**	<0.001	<0.001	**0.0085**	**0.0019**	**0.0068**	<0.001	<0.001	**0.403**	<0.001	<0.002	<0.001	<0.001	<0.001	**0.0027**
trans-1,2-DCE	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0025	**0.0024**	**0.0137**	<0.001	<0.001	<0.001	<0.001
TCE	**0.0028**	<0.001	**0.00078J**	**0.0182**	**0.0026**	**0.0047**	<0.001	<0.001	**0.163**	<0.001	**0.0017J**	**0.0009J**	<0.001	<0.001	**0.0079**
Vinyl chloride	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.0175**	**0.0029**	**0.176**	<0.001	**0.00023J**	<0.001	<0.001
Wet Chemistry															
Sulfate	**4.6**	**1.4J**	**9.4**	**1.6J**	**6.9**	**5.1**	**4.5**	**8.2**	**9.7**	**4.4**	**3.4J**	**9.3**	**3.9J**	**2.3J**	**2.4J**
Metals															
Manganese, dissolved	**0.238**	**0.0022J**	**0.0015J**	**0.0037J**	**0.0194**	**0.0179**	<0.005	**0.002J**	**1.47**	**2.24**	**3.25**	**0.0024J**	**0.00091J**	**0.0117**	**0.128**
Volatile Fatty Acids															
Acetic acid	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1Ju
Butyric acid	<1Ju	<1	<1	<1	<0.7Ju	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Lactic Acid	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Propionic acid	<1	<1	<0.3Ju	<1	<0.5Ju	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.6Ju
Pyruvic Acid	<10	<10	<10	<10	<10	<10	<10	<10	1.6J	<10	<10	<10	<10	<10	<10
Field Parameters															
Conductance, specific (µS/cm)	165	99	250	101	174	195	156	242	233	308	252	490	90	48	656
DO (mg/L)	0.63	6.30	4.98	5.34	0.79	5.55	2.88	1.86	0.31	0.57	0.6	3.83	8.02	7.40	0.60
Ferrous iron, dissolved (ppm)	0	0	0	0	0	0	0	0	1.0	1.0	0.8	0	0	0	1
ORP (mV)	101.7	210.4	124.9	137.9	108.9	84.5	143.8	125.8	-108.7	-124.7	-76.9	113.1	257.1	338.9	-103.4
pH (s.u.)	7.02	6.10	7.16	6.26	6.20	8.79	6.42	6.88	6.59	7.07	7.05	7.30	6.49	6.64	8.10
Temperature (°C)	15.77	16.87	16.66	17.91	15.99	15.64	15.85	15.05	18.23	19.21	18.56	15.20	15.16	14.79	18.92

(1) Analytical results are reported in milligrams per liter (mg/L) unless otherwise noted.

(2) Concentration is anomalous

B (inorganic) The analyte has been detected between the method detection limit and the reporting limit.

j Concentration considered an estimate based on data validation.

J Estimated concentration.

MO Matrix spike recovery was outside laboratory control limits.

NA Not analyzed.

< Concentration less than the Quantitation Limit or not validated if accompanied by "u" qualifier.

Bolding indicates constituent detection.

Table 3
Summary of Groundwater Analytical Results - January/February 2009
Medley Farm NPL Site, Gaffney, South Carolina

PARAMETER[1]	MW-3-2 02/03/09	MW-3D 01/29/09	MW-4-1 01/30/09	MW-4-2 01/30/09	SW-1 02/06/09	SW-101 02/03/09	SW-102 02/03/09	SW-103 01/28/09	SW-104 01/28/09	SW-106 01/21/09	SW-108 02/04/09	SW-201 02/03/09	SW-202 01/29/09	SW-3 01/29/09	SW-4 01/28/09
Volatile Organic Compounds															
1,1,1-TCA	<0.001	<0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	**0.0096**
1,1,2-TCA	**0.00089J**	<0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	**0.0022**
1,1-DCA	<0.001	<0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	**0.0014**
1,1-DCE	**0.003**	<0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	**0.0307**
1,2-DCA	<0.001	<0.05	<0.001	**0.0021**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	**0.00082J**
2-Butanone	<0.02	<1L1	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02L1	<0.02L1	<0.02L1	<0.02	<0.02	<0.02L1	<0.04L1	<0.02L1
Acetone	<0.02	<1L1	<0.02	<0.02	<0.02L1	<0.02	<0.02	<0.02L1	<0.02L1	<0.02L1	<0.02	<0.02	<0.02L1	<0.04L1	<0.02L1
Benzene	<0.001	**0.0688**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001
Chloroethane	<0.001	<0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001
Chloroform	**0.0042J**	<0.25	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	**0.0017J**	<0.005	<0.01	**0.0099**
Chloromethane	<0.001	<0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001
cis-1,2-DCE	**0.0116**	<0.05	<0.001	**0.0018**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.0011**	<0.001	<0.001	**0.006**	<0.001
Methylene chloride	<0.001	<0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001
PCE	**0.0231**	<0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.0141**	**0.003**	**0.002**	**0.274**	**0.0038**
trans-1,2-DCE	<0.001	<0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001
TCE	**0.0564**	<0.05	<0.001	<0.001	<0.001	**0.00077J**	<0.001	<0.001	<0.001	<0.001	**0.0159**	**0.0062**	**0.00064J**	**0.18**	**0.0398**
Vinyl chloride	**0.0013**	<0.05	**0.00023J**	**0.0066**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001
Wet Chemistry															
Sulfate	**5.3**	**19.9**[2]	**8.9**	**7.5**	**1.4J**	**5.3**	**4.2**	<4.0	**1.5J**	**8.2**	**4.6**	**1.7J**	**2.1J**	**3.5J**	**1.4M0J**
Metals															
Manganese, dissolved	**1.96**	**2.2**	**0.604**	**4.32**	<0.0044BJ u	**0.0125**	**0.00098J**	**0.117**	**0.0172**	**0.0072**	**0.0795**	**0.016**	**0.106**	**0.68**	**0.375**
Volatile Fatty Acids															
Acetic acid	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Butyric acid	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Lactic Acid	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Propionic acid	<1	<1	<0.4Ju	<1	<0.6Ju	<1	<1	<1	<1	<1	<1	<0.3Ju	<1	<1	<1
Pyruvic Acid	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Field Parameters															
Conductance, specific (µS/cm)	171	507	826	447	71	116	256	78	70	180	131	129	69	114	108
DO (mg/L)	0.84	0.24	0.84	1.10	7.41	4.99	3.05	6.80	6.50	7.07	3.61	5.27	2.24	4.08	5.44
Ferrous iron, dissolved (ppm)	3	1.5	0.8	1.0	0.1	0	0	0	0	0	0.2	0	0	0	0
ORP (mV)	12.3	-122.4	-83.3	-51.7	128.0	118.7	83.7	212.7	241.7	184.9	116.0	107.7	46.9	53.4	230.4
pH (s.u.)	6.82	7.07	7.45	7.02	6.21	6.50	6.47	5.89	5.74	6.21	6.42	6.09	5.84	6.50	5.83
Temperature (°C)	17.73	18.40	17.47	15.96	16.80	15.19	16.51	15.97	15.81	14.23	12.62	15.63	14.92	13.87	15.12

(1) Analytical results are reported in milligrams per liter (mg/L) unless otherwise noted.

(2) Concentration is anomalous

B (inorganic) The analyte has been detected between the method detection limit and the reporting limit.

j Concentration considered an estimate based on data validation.

J Estimated concentration.

MO Matrix spike recovery was outside laboratory control limits.

NA Not analyzed.

< Concentration less than the Quantitation Limit or not validated if accompanied by "u" qualifier.

Bolding indicates constituent detection.

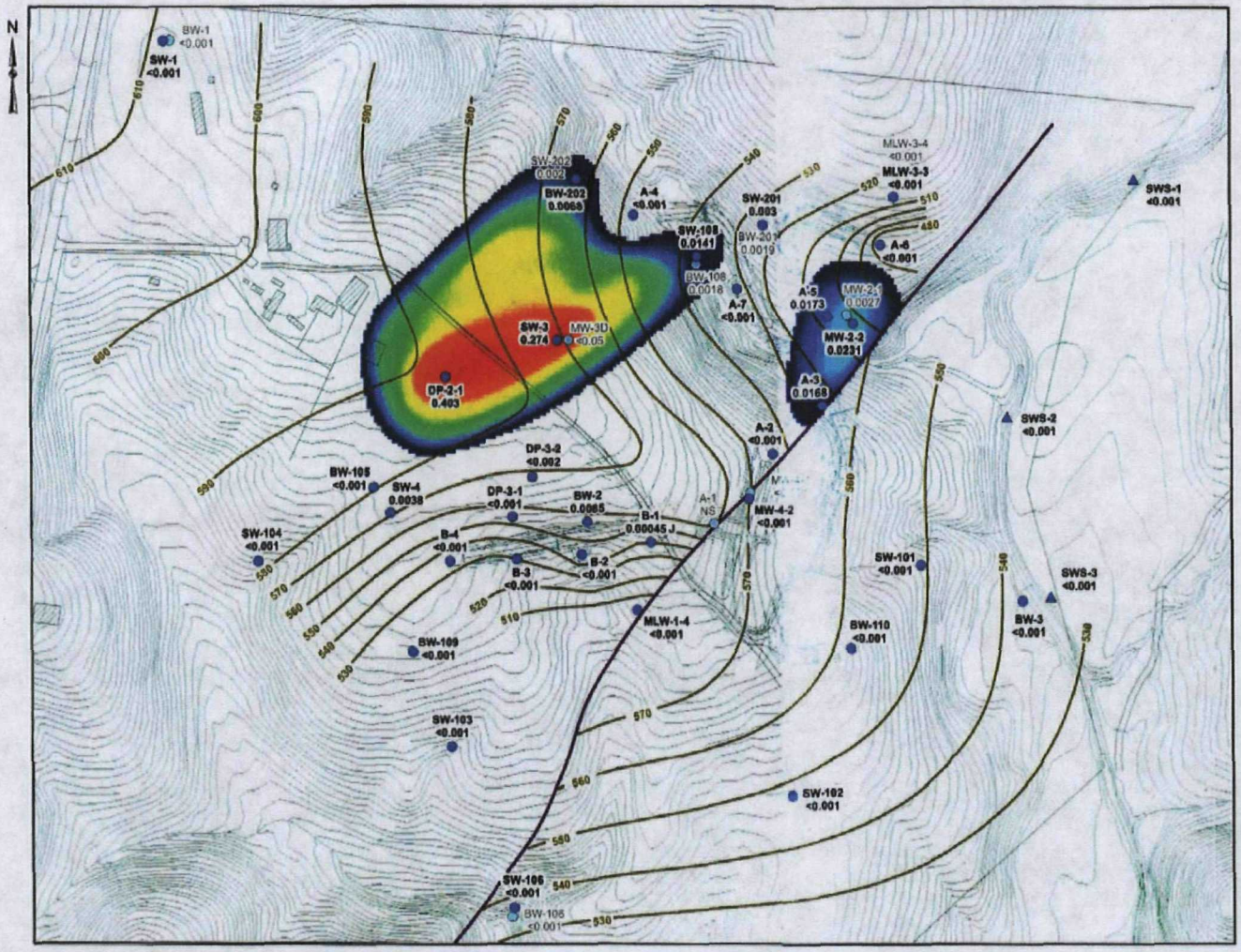
Item 3
Summary Table, Total Chlorinated Ethenes 2000 - 2009

Item 3: Data Summary, Total Chlorinated Ethenes 2000-2009
Medley Farm Drum Dump Superfund Site

November 2000		December 2001		September 2004		February 2006		September 2007		January 2009	
A-1	0.1165	A-1	0.3765	A-1	0.0879	A-2	0.0029	A-1	0.0157	A-2	0.0165
A-2	0.1487	A-2	0.2233	A-2	0.1573	A-3	0.0079	A-2	0.0362	A-3	0.0664
A-3	1.7840	A-3	0.3530	A-3	0.0455	A-4	0.0104	A-3	0.0606	A-4	0.0079
A-4	0.2569	A-4	0.0776	A-4	0.0063	A-5	0.0034	A-4	0.0163	A-5	0.1339
A-5	0.0018	A-5	0.0845	A-5	0.0882	A-6	0.0095	A-5	0.1395	A-6	0.0311
A-6	0.0015	A-6	0.0697	A-6	0.0330	A-7	0.0153	A-6	0.0311	A-7	0.0134
A-7	0.0015	A-7	0.0495	A-7	0.0497	B-1	0.0026	A-7	0.0134	B-1	0.0217
B-1	0.0114	B-1	0.0434	B-1	0.0500	B-2	0.0346	B-1	0.0200	B-2	0.0909
B-2	0.0475	B-2	0.0063	B-2	0.0277	B-3	0.0126	B-2	0.2087	B-3	0.3300
B-3	0.1041	B-3	0.0070	B-3	0.0988	B-4	0.0044	B-3	0.3374	B-4	0.0058
B-4	0.0015	B-4	0.0032	B-4	0.0368	BW-108	0.0028	B-4	0.0216	BW-105	0.0020
BW-105	0.2774	BW-105	0.0621	BW-108	0.0132	BW-109	0.0020	BW-105	0.0020	BW-108	0.0056
BW-108	0.0616	BW-108	0.0343	BW-109	0.0020	BW-2	0.0285	BW-108	0.0148	BW-109	0.0020
BW-110	0.0122	BW-110	0.0060	BW-2	0.0610	BW-201	0.0020	BW-109	0.0020	BW-110	0.0023
BW-201	0.0846	BW-201	0.0040	BW-201	0.0028	DP-3-1	0.0520	BW-110	0.0023	BW-2	0.0314
BW-3	0.0954	DP-3-1	0.5495	DP-3-1	0.4163	DP-3-2	0.0071	BW-2	0.0260	BW-201	0.0055
DP-2-1	0.0615	MLW-1-1	0.2818	DP-3-2	0.2529	MLW-1-1	0.0017	BW-201	0.0021	BW-3	0.0020
DP-3-1	0.2377	MLW-1-2	0.0719	MLW-1-1	0.0020	MLW-1-2	0.0018	BW-3	0.0020	DP-2-1	0.6825
DP-3-2	1.0240	MLW-1-3	0.1385	MLW-1-2	0.0020	MLW-1-3	0.0020	DP-2-1	0.1954	DP-3-1	0.0061
MLW-1-1	0.2826	MLW-3-1	0.0071	MLW-1-3	0.0020	MLW-1-4	0.0034	DP-3-1	0.2238	DP-3-2	0.3937
MLW-1-2	0.0026	MLW-3-2	0.0032	MLW-3-1	0.0113	MLW-3-1	0.0025	DP-3-2	0.4662	MLW-1-4	0.0024
MLW-1-3	0.0026	MLW-3-3	0.0021	MLW-3-2	0.0117	MLW-3-2	0.0222	MLW-1-1	0.0017	MLW-3-3	0.0361
MLW-3-1	0.0131	MW-2-1	0.0015	MLW-3-3	0.0041	MLW-3-3	0.0608	MLW-1-2	0.0020	MLW-3-4	0.0020
MLW-3-2	0.0052	MW-2-2	0.0091	MW-2-1	0.0417	MLW-3-4	0.0985	MLW-1-3	0.0020	MW-2-1	0.0141
MLW-3-3	0.0015	MW-3D	0.0029	MW-2-2	0.0648	MW-2-1	0.0937	MLW-1-4	0.0022	MW-2-2	0.0924
MW-2-1	0.0015	MW-4-1	0.0053	MW-3D	0.2235	MW-2-2	0.0018	MLW-3-2	0.0195	MW-3D	0.0100
MW-2-2	0.0015	MW-4-2	0.0015	MW-4-1	0.1092	MW-3D	0.0020	MLW-3-3	0.0295	MW-4-1	0.0020
MW-4-1	0.0015			MW-4-2	0.2945	MW-4-1	0.0028	MLW-3-4	0.0115	MW-4-2	0.0094
MW-4-2	0.2364					MW-4-2	0.0020	MW-2-1	0.0020		
								MW-2-2	0.0702		
								MW-3D	0.2950		
								MW-4-1	0.0025		
								MW-4-2	0.0086		

Well designation at left
Concentration in micrograms/liter to right

Item 4
Groundwater Plume Maps, Medley Farm NPL Site
RMT Technical Memorandum, May 2009



Map Document: (P:\Hydro\71243\ArcGIS\2009Report\PCE2009Q1_11x17.mxd)
4/30/2009 – 2:52:17 PM

LEGEND

- MONITORING WELL (RESULTS USED FOR CREATING CONCENTRATION CONTOURS)
- MONITORING WELL (RESULTS NOT USED FOR CREATING CONCENTRATION CONTOURS)
- SURFACE WATER SAMPLE LOCATIONS
- TOP OF BEDROCK ELEVATION CONTOUR
- FAULT

TETRACHLOROETHENE CONCENTRATION

- 0.1 mg/L
- 0.05 mg/L
- 0.005 mg/L

NOTES

TETRACHLOROETHENE CONCENTRATIONS ARE POSTED IN mg/L

NS - NOT SAMPLED

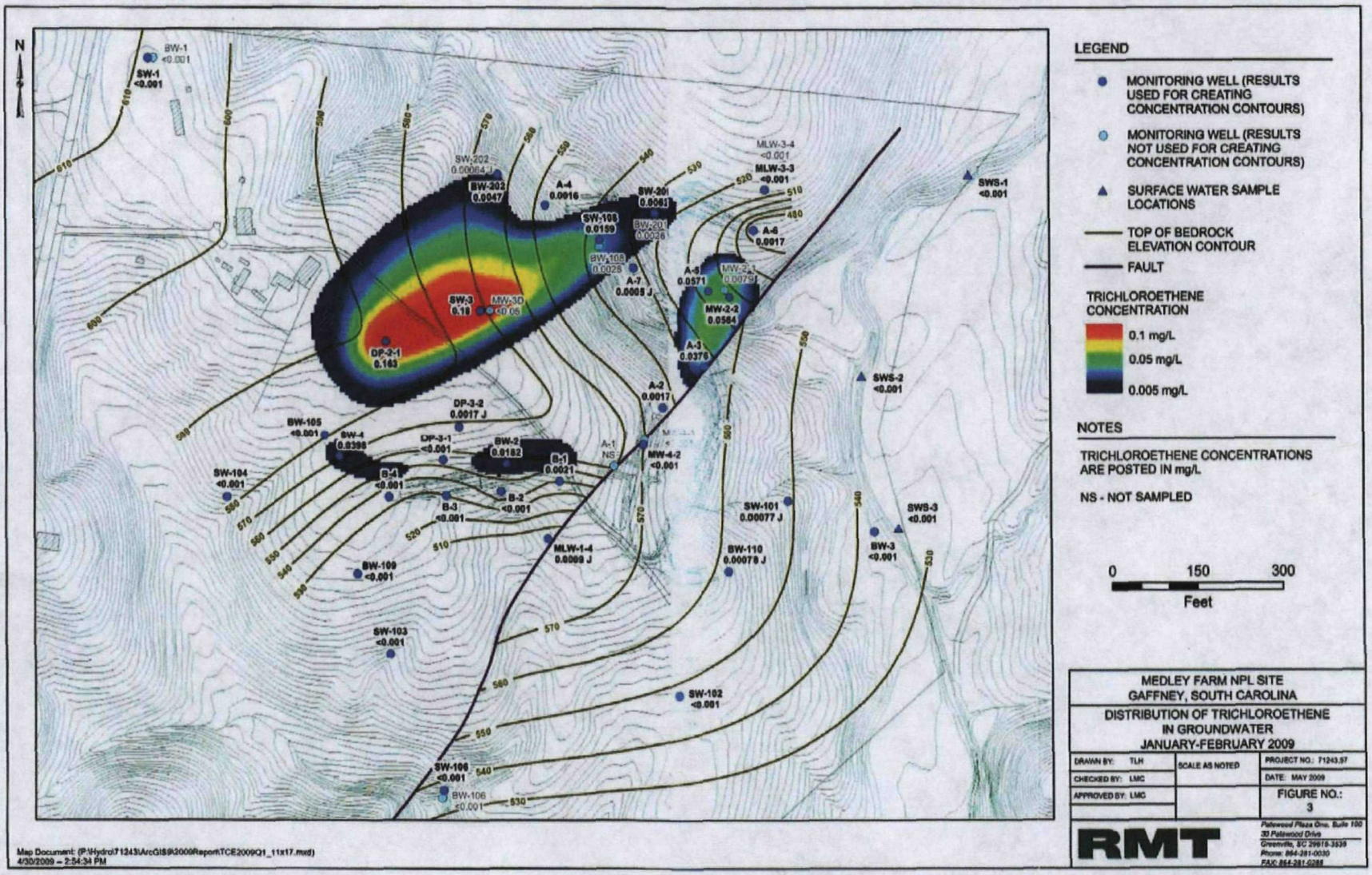
0 150 300
Feet

MEDLEY FARM NPL SITE
GAFFNEY, SOUTH CAROLINA

DISTRIBUTION OF TETRACHLOROETHENE IN GROUNDWATER
JANUARY-FEBRUARY 2009

DRAWN BY: TJH	SCALE AS NOTED	PROJECT NO.: T1243.57
CHECKED BY: LMC		DATE: MAY 2009
APPROVED BY: LMC		FIGURE NO.: 2

RMT
Patewood Plaza One, Suite 100
30 Patewood Drive
Greenville, SC 29615-3535
Phone: 864-281-0030
FAX: 864-281-0288



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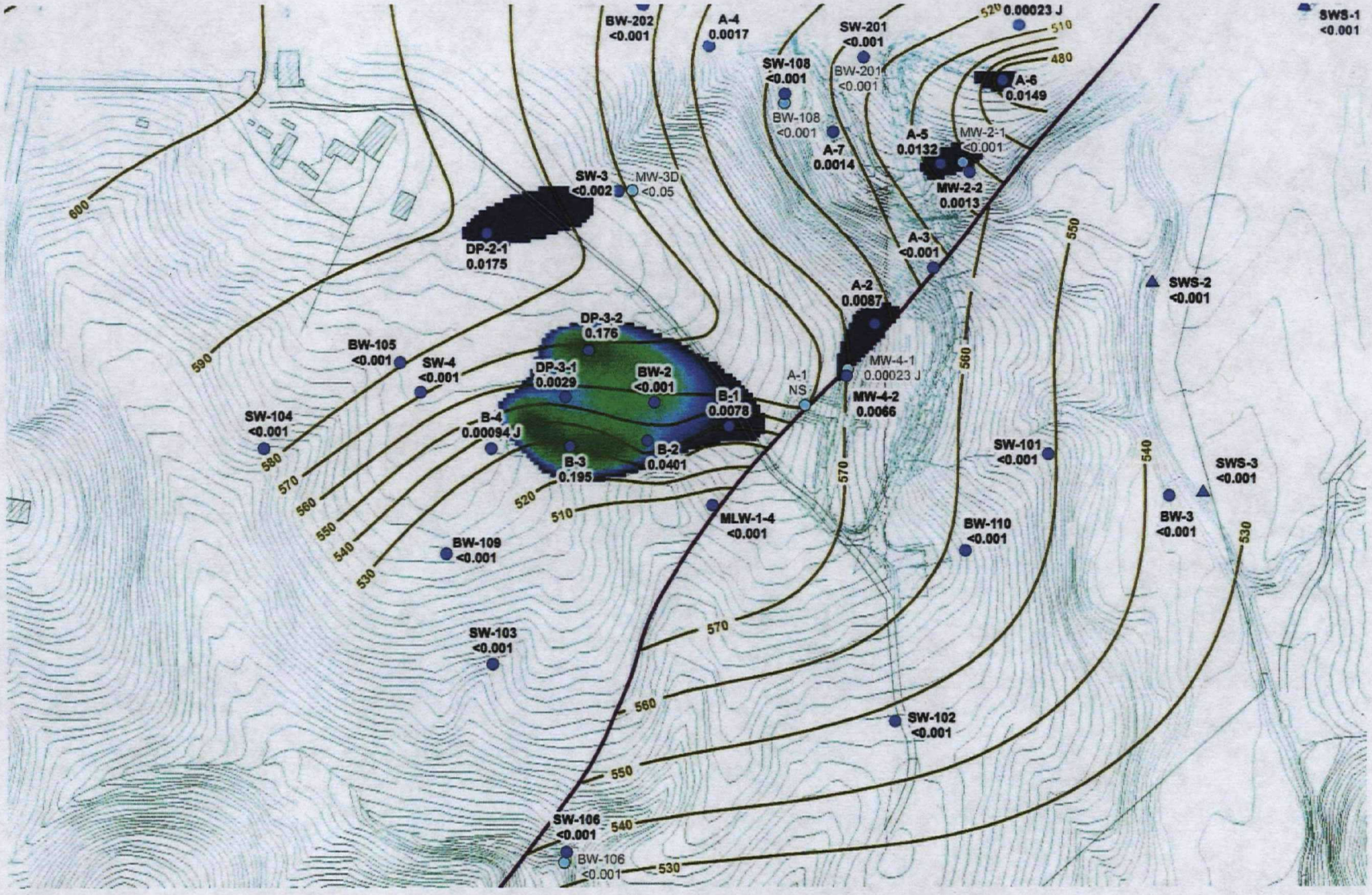
4/30/2009 – 2:54:34 PM

MEDLEY FARM NPL SITE
GAFFNEY, SOUTH CAROLINA

DISTRIBUTION OF TRICHLOROETHENE IN GROUNDWATER
JANUARY-FEBRUARY 2009

DRAWN BY: TLH	SCALE: AS NOTED	PROJECT NO.: 71243.57
CHECKED BY: LMC		DATE: MAY 2009
APPROVED BY: LMC		FIGURE NO.: 3

RMT
Patewood Plaza One, Suite 150
30 Patewood Drive
Greenville, SC 29615-3539
Phone: 864-281-0030
FAX: 864-281-0288



DISTRIBUTION OF VINYL CHLORIDE JAN./FEB. 2009

ATTACHMENT E
Site Inspection Records

Site Inspection Memorandum

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

February 27, 2009

MEMORANDUM

SUBJECT: Site visits and inspections
Five Year Review process, 2009

TO: Site Files
Medley Farm Drum Dump, Gaffney, Cherokee Co., SC

FROM: Ralph O. Howard, Jr., Remedial Project Manager
Superfund Remedial & Site Evaluation Branch,
Superfund Division

This memorandum documents two site visits/inspections completed in January and February 2009, as part of the Five Year Review (5YR) process. A 5YR is in progress for this site. In accordance with 5YR guidance, a Five Year Review Site Inspection Checklist was completed based upon the inspections and is attached to this memorandum as Attachment 1. No significant problems, shortcomings or issues were noted during the inspections.

January 21, 2009 Site Visit

On January 21, 2009, the RPM conducted a site visit and walk-through at the Medley Farm Site. Attending, with affiliations, were the following six (6) persons:

Name	Role	Affiliation
Ralph Howard	EPA Remedial Project Manager	US EPA Region 4
Greg Cassidy	SC DHEC Project Manager	SC Dept. Health and Envir-
Chuck Williams	SC DHEC Hydrogeologist	onmental Control (SCDHEC)
Steve Webb	Project Manager	RMT, Inc. (PRP Consultant)
Caitlin Current	Project Hydrogeologist	RMT, Inc.
Lisa Clark	Staff Hydrogeologist	RMT, Inc.

A photocopy of the attendees' business cards is provided as Attachment 2. Personnel were onsite for about two hours, from 1:00 to 3:00 PM. Webb and Howard led the group on a walking tour and inspection of the accessible portions of the 67-acre property, focusing mainly on the infrastructure present in the areas where remediation has been performed. These areas lie along the site entrance road and along Recovery Well Lines A and B, on the main cleared field area (the three soil vapor extraction (SVE) treatment areas), the water treatment building, and the

discharge point and flow-measuring weir located downhill of the treatment building on Jones Creek.

The attached Figures 1 and 2 show the locations of the site, and of all infrastructure components mentioned above. The site is not fenced; however entry is restricted by a gate across the road at the location shown.

The infrastructure inspected includes forty (40) wells and piezometers usable in site groundwater treatments and monitoring, of which thirty (30) are currently used in the site monitoring program. All wells have lockable caps, and random checks indicated that they have functioning hinged caps with serviceable locks. To document the items observed, a Superfund Five-Year Review Checklist (Attachment 1) is attached. A set of photographs, mostly taken during this inspection plus a few useful ones taken in 2005, are provided as Attachment 3.

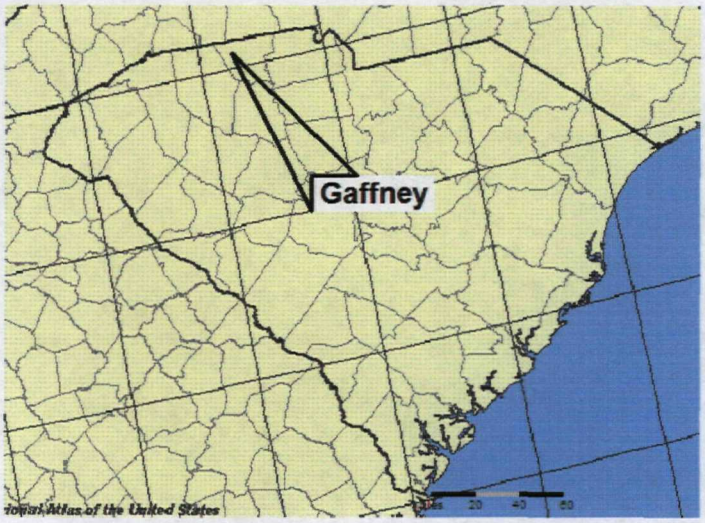
After the site visit concluded, the RPM toured the immediate site surrounding area to verify land use conditions, and to observe A) Jones Creek streamflow conditions at the downstream bridge on Round Tree Road (SC Hwy SC-11-393), about two-thirds of a mile SSE of the site, and B) Thicketty Creek streamflow at the bridge on Burnt Gin Road, about 1.6 miles to the south. The rural character of the surrounding area was seen to be virtually unchanged since the 1990s and the time of the Record of Decision (1991). The predominant land uses near the site remain agricultural (farming), and pine- and mixed-wood forest.

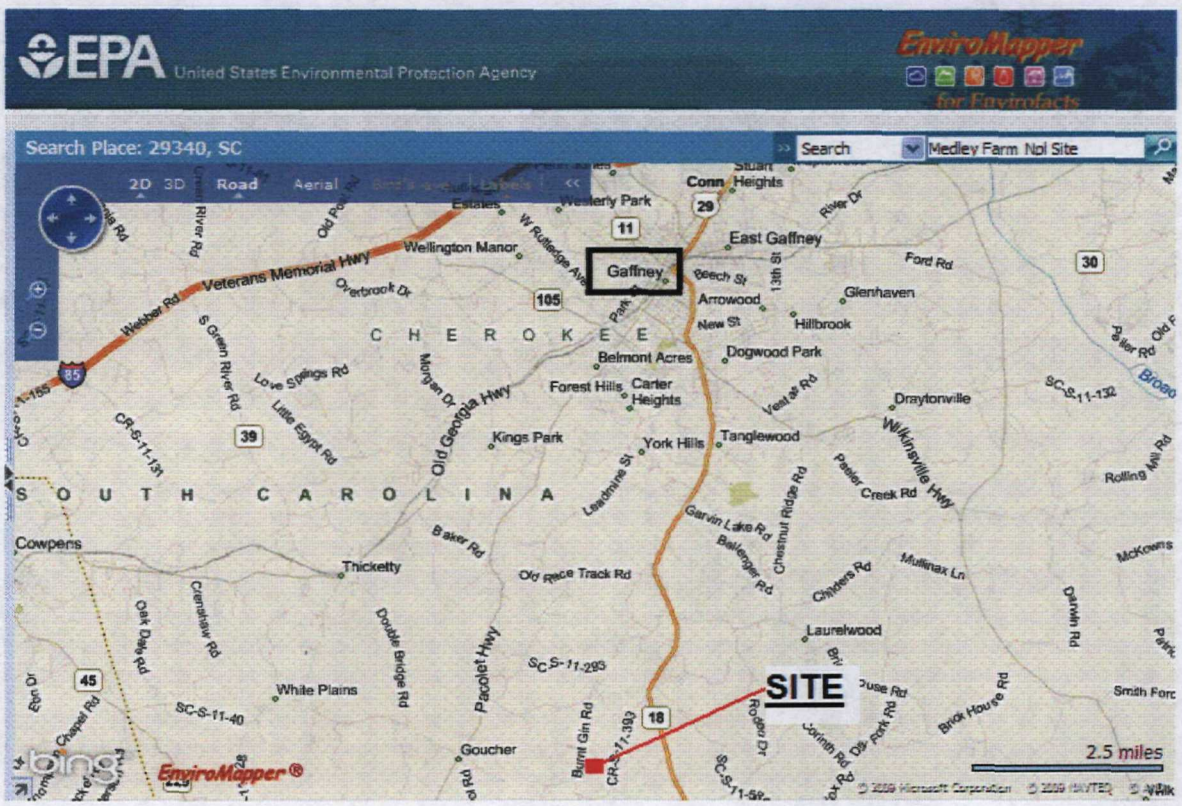
On June 22, 2009, prior to returning to Atlanta, the RPM visited the information repository used for all Superfund activities to date, which is the Cherokee County Main Library located at 300 E. Rutledge Street, in Gaffney. Materials available there were plentiful but are dated, and lacking in recent reports or information. This will be addressed and the improvement documented in the Five Year Review.

<u>February 26, 2009 Site Visit</u>

A second site visit was conducted at the site in February 2009. The main purpose of this visit was to familiarize the assigned Community Involvement Coordinator (CIC) with the site as part of preparations and work for the Five Year Review. The RPM and Coordinator (Ms. Sherryl Carbonaro) were accompanied on a foot reconnaissance of the site by property owner Mr. Sam Medley. After the reconnaissance the RPM and CIC completed a driving tour similar to that completed in January. On the preceding evening after arriving in Gaffney, February 25, the RPM and CIC met at his request with local nearby property owner Mr. Johnny Goode, who owns land across Burnt Gin Road to the west from the Medley property. Mr. Goode expressed no particular concerns or questions about the status of site cleanup; however at present he is in an ownership dispute with Same Medley, whom he contends has actually sold him the property. The RPM and assigned attorney at EPA are aware of the situation and have been communicating regularly with both Mr. Goode and his attorney, and Mr. Medley and his attorney. Mr. Goode understands EPA has no position on the matter nor on who owns the property. This discussion (Feb. 25) centered on any of his concerns about the site and his impressions and/or knowledge of whether his neighbors have any concerns. Mr. Goode does not believe his neighbors have any concerns about the ongoing cleanup.

Figure 1 – Site Location





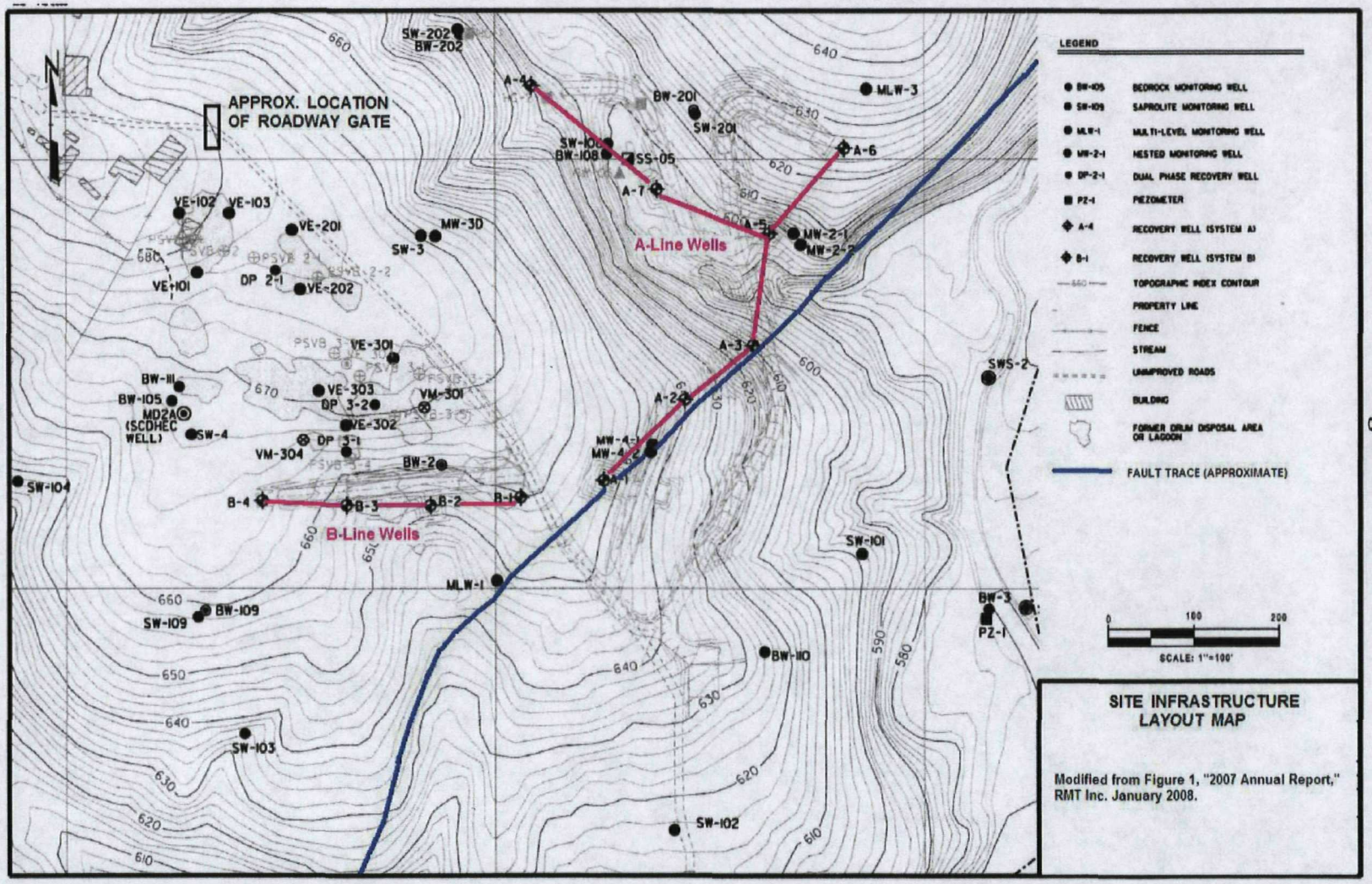

APPROX. LOCATION OF ROADWAY GATE
A-Line Wells
B-Line Wells
SW-202
BW-202
BW-201
SW-201
MLW-3
SW-108
BW-108
SS-05
A-4
A-6
A-7
A-5
MW-2-1
MW-2-2
A-3
A-2
A-1
MW-4-1
MW-4-2
VE-102
VE-103
VE-201
MW-30
SW-3
VE-101
DP 2-1
VE-202
VE-301
VM-301
VE-303
DP 3-2
VE-302
DP 3-1
VM-304
BW-2
BW-111
BW-105
MD2A (SCDHEC WELL)
SW-4
SW-104
B-4
B-3
B-2
B-1
SWS-2
SW-101
MLW-1
BW-109
SW-109
BW-110
BW-3
PZ-1
SW-103
SW-102
LEGEND
BEDROCK MONITORING WELL
SAPROLITE MONITORING WELL
MULTI-LEVEL MONITORING WELL
NESTED MONITORING WELL
DUAL PHASE RECOVERY WELL
PIEZOMETER
RECOVERY WELL (SYSTEM A)
RECOVERY WELL (SYSTEM B)
TOPOGRAPHIC INDEX CONTOUR
PROPERTY LINE
FENCE
STREAM
UNIMPROVED ROADS
BUILDING
FORMER DRUM DISPOSAL AREA OR LAGOON
FAULT TRACE (APPROXIMATE)
0
100
200
SCALE: 1"=100'
SITE INFRASTRUCTURE LAYOUT MAP
Modified from Figure 1, "2007 Annual Report," RMT Inc. January 2008.

Figure 2

Attachment 1
Site Inspection Checklist

Five-Year Review Site Inspection Checklist

Preparer: RPM Ralph O. Howard, Jr.

I. SITE INFORMATION

Site name: Medley Farm Drum Dump	**Date of inspection:** 1-21-2009
Location and Region: Godfrey SC; EPA Region 4	**EPA ID:** SCD 980 558 142
Agency, office, or company leading the five-year review: US EPA Region 4	**Weather/temperature:** Chilly (40s), bright/clear/sunny

Remedy Includes: (Check all that apply)

- G Landfill cover/containment
- G Access controls
- G Institutional controls
- G Groundwater pump and treatment
- G Surface water collection and treatment
- G Monitored natural attenuation
- G Groundwater containment
- G Vertical barrier walls
- ● Other In-situ treatment of groundwater - enhanced biodegradation, reductive dechlorination.

See Atch. D to 2009 5-Yr. Review Report.

Attachments: ● Inspection team roster attached ● Site map attached Attached memo

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Mr. Steve Webb (Name) Project Manager (Title) 4-1-2009 (Date)
   Interviewed G at site G at office ● by phone Phone no. (864) 234-9363
   Problems, suggestions; ● Report attached _____

2. **O&M staff** _____ (Name) _____ (Title) _____ (Date)
   Interviewed G at site G at office G by phone Phone no. _____
   Problems, suggestions; G Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency SC Dept. Health + Env. Control (SCDHEC)
Contact Mr. Greg Cassidy — Project Manager — 4-28-09 — (803)896-4178
Name — Title — Date — Phone no.
Problems; suggestions; ● Report attached _____

Agency _____
Contact _____ — _____ — _____ — _____
Name — Title — Date — Phone no.
Problems; suggestions; G Report attached _____

Agency _____
Contact _____ — _____ — _____ — _____
Name — Title — Date — Phone no.
Problems; suggestions; G Report attached _____

Agency _____
Contact _____ — _____ — _____ — _____
Name — Title — Date — Phone no.
Problems; suggestions; G Report attached _____

4. **Other interviews** (optional) ● Report attached.

Site property owner and a nearby resident, as described in the memorandum that appears in Attachment D of the 2009 Five Year Review.

INTERVIEW RECORD

Site Name: Medley Farm Drum Dump Site	EPA ID No.:	
Subject: Interview for 5-Year Review	Time: 1400-1425	Date: 4-1-09
Type: ☑ Telephone ☐ Visit ☐ Other Location of Visit:	☐ Incoming	☑ Outgoing

Contact Made By:

Name: Ralph Howard	Title: RPM	Organization: EPA Reg. 4

Individual Contacted:

Name: Steve Webb	Title: Project Manager	Organization: RMT, Inc.
Telephone No: 864-234-9363 Fax No: E-Mail Address: Steve.Webb@rmtinc.com	Street Address: 30 Patewood Drive Suite 100 City, State, Zip: Greenville SC 29615	

Summary Of Conversation

- The questions asked followed along from App. C, pg. C-6 of the 5YR guidance. Focuses mainly on performance, operation and maintenance issues/problems.
- Looking at the period since 2004, Steve says it's been a continuous learning process, learning how each well and nearby area responds to injection; how the aquifer tends to remain "reducing" and resist changing back to oxidized; how to optimize the treatment-solution prep work; and so on.
  - The wells de-commissioning work done in 2006-07 (Recovery wells, A and B-line) has allowed these large-diameter wells to be used to inject much greater volumes of treatment solution.
- A major issue for them continues to be figuring out "how will we determine when we're completed," and how to finish the remedial action.

INTERVIEW RECORD

Site Name: Medley Farm Drum Dump Site		**EPA ID No.:**
Subject: Interview for 5-Year Review		**Time:** 1315-1345 **Date:** 4-28-09
Type: ☑ Telephone ☐ Visit ☐ Other **Location of Visit:**		☐ Incoming ☑ Outgoing

Contact Made By:

Name: Ralph Howard	**Title:** RPM	**Organization:** EPA Reg. 4

Individual Contacted:

Name: Greg Cassidy	**Title:** Project Manager	**Organization:** SC DHEC
Telephone No: 803-896-4178 **Fax No:** **E-Mail Address:** cassidga@dhec.sc.gov		**Street Address:** 2600 Bull Street **City, State, Zip:** Columbia, SC 29201

Summary Of Conversation

- We discussed whether he knew of any SC laws or regulations that are new or changed, that could or should affect the remedy. There are none, he says, but he will be checking further.
- As far as remedy operations and progress, he indicates they have no issues beyond those expressed in the periodic comments issued.
- I asked about any contacts via phone or email he's received, from anyone locally (Gaffney SC). Greg says no calls/contacts from general public, or, city or county or DHEC district. At the start of the ownership dispute (Mr. Medley, Mr. John Goode) he got a call from Medley's attorney Mr. Weatherford (Spring-2008). Nothing else.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   - G O&M manual — G Readily available — G Up to date — G N/A
   - G As-built drawings — G Readily available — G Up to date — G N/A
   - G Maintenance logs — G Readily available — G Up to date — G N/A
   - Remarks

2. **Site-Specific Health and Safety Plan** — G Readily available — G Up to date — G N/A
   - G Contingency plan/emergency response plan — G Readily available — G Up to date — G N/A
   - Remarks

3. **O&M and OSHA Training Records** — G Readily available — G Up to date — ⊗ N/A
   - Remarks PRP Contractor maintains for their personnel.

4. **Permits and Service Agreements**
   - G Air discharge permit — G Readily available — G Up to date — ● N/A
   - G Effluent discharge — G Readily available — ● Up to date — G N/A
   - G Waste disposal, POTW — G Readily available — G Up to date — ● N/A
   - G Other permits Und. Injection — G Readily available — ● Up to date — G N/A
   - Remarks UIC and NPDES; maintained by PRP contractor and SCDHEC.

5. **Gas Generation Records** — G Readily available — G Up to date — ● N/A
   - Remarks

6. **Settlement Monument Records** — G Readily available — G Up to date — ● N/A
   - Remarks

7. **Groundwater Monitoring Records** — G Readily available — G Up to date — G N/A
   - Remarks

8. **Leachate Extraction Records** — G Readily available — G Up to date — ● N/A
   - Remarks

9. **Discharge Compliance Records**
   - G Air — G Readily available — G Up to date — G N/A
   - G Water (effluent) — ● Readily available — ● Up to date — G N/A
   - Remarks Maintained by PRP contractor & State of SC (SCDHEC).

10. **Daily Access/Security Logs** — G Readily available — G Up to date — ⊗ N/A
    - Remarks

IV. O&M COSTS

1. **O&M Organization**

G State in-house G Contractor for State
⊗ PRP in-house ⊗ Contractor for PRP
G Federal Facility in-house G Contractor for Federal Facility
G Other See section 4.C. of this (2009) Five Year Review Report.

2. **O&M Cost Records** See above ↗.

G Readily available G Up to date
G Funding mechanism/agreement in place
Original O&M cost estimate _____ G Breakdown attached

Total annual cost by year for review period if available

From _____ To _____ _____ G Breakdown attached
Date Date Total cost
From _____ To _____ _____ G Breakdown attached
Date Date Total cost
From _____ To _____ _____ G Breakdown attached
Date Date Total cost
From _____ To _____ _____ G Breakdown attached
Date Date Total cost
From _____ To _____ _____ G Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS G Applicable G N/A

A. Fencing

1. **Fencing damaged** G Location shown on site map ⊗ Gates secured G N/A

Remarks Site not fenced, but gate across entrance road is maintained by resident (Mr. Medley) and PRP Contractor.

B. Other Access Restrictions

1. **Signs and other security measures** G Location shown on site map G N/A

Remarks _____

C. Institutional Controls (ICs) ☒ See discussion of section 7.A. in this Five Year Review Report.

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented G Yes G No G N/A

Site conditions imply ICs not being fully enforced G Yes G No G N/A

Type of monitoring (*e.g.*, self-reporting, drive by) _____

Frequency _____

Responsible party/agency _____

Contact _____ _____ _____ _____

Name Title Date Phone no.

Reporting is up-to-date G Yes G No G N/A

Reports are verified by the lead agency G Yes G No G N/A

Specific requirements in deed or decision documents have been met G Yes G No G N/A

Violations have been reported G Yes G No G N/A

Other problems or suggestions: G Report attached

_____

_____

_____

_____

2. **Adequacy** G ICs are adequate G ICs are inadequate G N/A

Remarks _____

_____

_____

D. General

1. **Vandalism/trespassing** G Location shown on site map ⊗ No vandalism evident

Remarks _____

_____

2. **Land use changes on site** G N/A

Remarks None; none observed in surrounding area.

_____

3. **Land use changes off site** G N/A

Remarks _____

_____

VI. GENERAL SITE CONDITIONS

A. Roads G Applicable G N/A

1. **Roads damaged** G Location shown on site map ⊗ Roads adequate G N/A

Remarks _____

_____

B. Other Site Conditions

Remarks_____

VII. LANDFILL COVERS G Applicable ⊗ N/A

A. Landfill Surface

1. **Settlement** (Low spots) G Location shown on site map G Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Cracks** G Location shown on site map G Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. **Erosion** G Location shown on site map G Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** G Location shown on site map G Holes not evident
   Areal extent_____ Depth_____
   Remarks_____

5. **Vegetative Cover** G Grass G Cover properly established G No signs of stress
   G Trees/Shrubs (indicate size and locations on a diagram)
   Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** G N/A
   Remarks_____

7. **Bulges** G Location shown on site map G Bulges not evident
   Areal extent_____ Height_____
   Remarks_____

8. **Wet Areas/Water Damage** G Wet areas/water damage not evident
G Wet areas G Location shown on site map Areal extent_____
G Ponding G Location shown on site map Areal extent_____
G Seeps G Location shown on site map Areal extent_____
G Soft subgrade G Location shown on site map Areal extent_____
Remarks_____

9. **Slope Instability** G Slides G Location shown on site map G No evidence of slope instability
Areal extent_____
Remarks_____

B. Benches G Applicable G N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** G Location shown on site map G N/A or okay
Remarks_____

2. **Bench Breached** G Location shown on site map G N/A or okay
Remarks_____

3. **Bench Overtopped** G Location shown on site map G N/A or okay
Remarks_____

C. Letdown Channels G Applicable G N/A
(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** G Location shown on site map G No evidence of settlement
Areal extent_____ Depth_____
Remarks_____

2. **Material Degradation** G Location shown on site map G No evidence of degradation
Material type_____ Areal extent_____
Remarks_____

3. **Erosion** G Location shown on site map G No evidence of erosion
Areal extent_____ Depth_____
Remarks_____

4. **Undercutting** G Location shown on site map G No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ G No obstructions
G Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
G No evidence of excessive growth
G Vegetation in channels does not obstruct flow
G Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations G Applicable G N/A

1. **Gas Vents** G Active G Passive
G Properly secured/locked G Functioning G Routinely sampled G Good condition
G Evidence of leakage at penetration G Needs Maintenance
G N/A
Remarks_____

2. **Gas Monitoring Probes**
G Properly secured/locked G Functioning G Routinely sampled G Good condition
G Evidence of leakage at penetration G Needs Maintenance G N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
G Properly secured/locked G Functioning G Routinely sampled G Good condition
G Evidence of leakage at penetration G Needs Maintenance G N/A
Remarks_____

4. **Leachate Extraction Wells**
G Properly secured/locked G Functioning G Routinely sampled G Good condition
G Evidence of leakage at penetration G Needs Maintenance G N/A
Remarks_____

5. **Settlement Monuments** G Located G Routinely surveyed G N/A
Remarks_____

E. Gas Collection and Treatment G Applicable G N/A

1. **Gas Treatment Facilities**
   G Flaring G Thermal destruction G Collection for reuse
   G Good condition G Needs Maintenance
   Remarks_____

2. **Gas Collection Wells, Manifolds and Piping**
   G Good condition G Needs Maintenance
   Remarks_____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   G Good condition G Needs Maintenance G N/A
   Remarks_____

F. Cover Drainage Layer G Applicable G N/A

1. **Outlet Pipes Inspected** G Functioning G N/A
   Remarks_____

2. **Outlet Rock Inspected** G Functioning G N/A
   Remarks_____

G. Detention/Sedimentation Ponds G Applicable G N/A

1. **Siltation** Areal extent_____ Depth_____ G N/A
   G Siltation not evident
   Remarks_____

2. **Erosion** Areal extent_____ Depth_____
   G Erosion not evident
   Remarks_____

3. **Outlet Works** G Functioning G N/A
   Remarks_____

4. **Dam** G Functioning G N/A
   Remarks_____

H. Retaining Walls G Applicable G N/A

1. **Deformations** G Location shown on site map G Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** G Location shown on site map G Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge G Applicable G N/A

1. **Siltation** G Location shown on site map G Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. ***Vegetative Growth*** G Location shown on site map G N/A
   G Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** G Location shown on site map G Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** G Functioning G N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS G Applicable ☒ N/A

1. **Settlement** G Location shown on site map G Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   G Performance not monitored
   Frequency_____ G Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES (X) Applicable G N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines G Applicable G N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   (X) Good condition G All required wells properly operating G Needs Maintenance G N/A
   Remarks No active pumping · elec. lines below grade. Elec. power-on-pole to treatment bldg. is functional.

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   (X) Good condition G Needs Maintenance
   Remarks Pipelines + vaults below grade.

3. **Spare Parts and Equipment**
   G Readily available G Good condition G Requires upgrade G Needs to be provided
   Remarks

B. Surface Water Collection Structures, Pumps, and Pipelines G Applicable G N/A

1. **Collection Structures, Pumps, and Electrical**
   G Good condition G Needs Maintenance
   Remarks

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   G Good condition G Needs Maintenance
   Remarks

3. **Spare Parts and Equipment**
   G Readily available G Good condition G Requires upgrade G Needs to be provided
   Remarks

C. Treatment System G Applicable G N/A

1. **Treatment Train** (Check components that apply) N/A at present.
   G Metals removal G Oil/water separation G Bioremediation
   G Air stripping G Carbon adsorbers
   G Filters_____
   G Additive (*e.g.*, chelation agent, flocculent)_____
   G Others_____
   G Good condition G Needs Maintenance
   G Sampling ports properly marked and functional
   G Sampling/maintenance log displayed and up to date
   G Equipment properly identified
   G Quantity of groundwater treated annually_____
   G Quantity of surface water treated annually_____
   Remarks_____

2. **Electrical Enclosures and Panels** (properly rated and functional)
   G N/A G Good condition G Needs Maintenance
   Remarks Control panel at Trtmt. Bldg. – No obvious issues.

3. **Tanks, Vaults, Storage Vessels**
   G N/A G Good condition G Proper secondary containment G Needs Maintenance
   Remarks_____

4. **Discharge Structure and Appurtenances**
   G N/A ⊗ Good condition G Needs Maintenance
   Remarks Diffuser-pipe at Jones Creek – OK condition.

5. **Treatment Building(s)**
   G N/A ⊗ Good condition (esp. roof and doorways) G Needs repair
   G Chemicals and equipment properly stored
   Remarks_____

6. **Monitoring Wells** (pump and treatment remedy)
   ⊗ Properly secured/locked G Functioning ⊗ Routinely sampled G Good condition
   G All required wells located G Needs Maintenance G N/A
   Remarks_____

D. Monitoring Data

1. Monitoring Data
   ⊗ Is routinely submitted on time ⊗ Is of acceptable quality

2. Monitoring data suggests:
   ⊗ Groundwater plume is effectively contained ⊗ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
G Properly secured/lockedG Functioning G Routinely sampled G Good condition
G All required wells located G Needs Maintenance G N/A
Remarks

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

(See text of Five Year Review Report.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

(See text of Five Year Review Report.)

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Attachment 2
Business cards, Site Inspection Attendees 1/21/2009

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Senior Project Manager

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D H E C
PROMOTE. PROTECT. PROSPER.

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SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

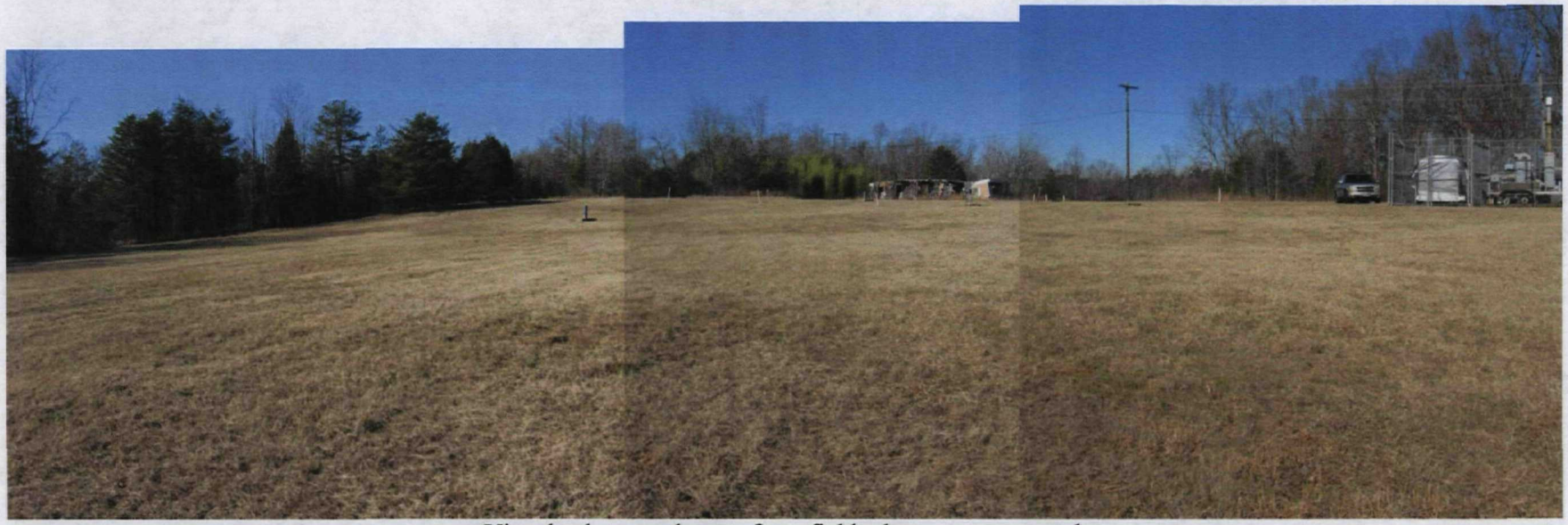
Attachment 3
Site Inspection Photographs

Satellite view (USGS imagery 2008) of site and surrounding area. Hatched area denotes former disposal areas. Site boundaries approximate.

January 2009 Photographs

View facing southeast from road, over main open-field area of site. B-Line wells run left to right in front of treeline.

"Mothballed" soil vapor extraction blower unit and piping.



View back to northwest, from field, along entrance road.

View looking southeast along road, to water treatment building (fenced/ metal roof visible); road turns hard-left, north, to A-Well Line.

View opposite that at left, northwestward.

NPDES Outfall on Jones Creek, with Diffuser.

Closer view of diffuser (April 2008)

December 2005 Photographs

A-Line wells. Left: Well A-2, view facing northeast. Right: Well A-6, northeast limit of A-Line. View faces north.

Information Repository: Cherokee County (SC) Main Library, in Gaffney.

ATTACHMENT F
Review of ARARs and Risk Criteria, Selected Remedy

Item 1
Review of Selected Remedy Risk Criteria for 2009 Five-Year Review
Medley Farm NPL Site, Gaffney, SC

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 4

61 Forsyth Street, S.W.
Atlanta, Georgia 30303

MEMORANDUM

April 20, 2009

SUBJECT: 2009 Five-Year Review Report
Medley Farm Site
Gaffney, Cherokee County, South Carolina

FROM: Ofia Hodoh
Technical Services Section
Superfund Support Branch

TO: Ralph Howard, RPM
Superfund Remedial and Site Evaluation Branch

THROUGH: Glenn Adams, Chief
Technical Services Section
Superfund Support Branch

Per your request, I have reviewed the **Record of Decision (05/29/1991)** and **Second Five-Year Review Report (09/2004)** for the **Medley Farm Drum Dump Site,** in **Gaffney, South Carolina**. My review has focused on the human health risk aspects of the document, related to the Comprehensive Five-Year Review Guidance (EPA 2001b), Section 4.2, Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

Specific Comments

1. Changes in Exposure Pathways:
The exposure assumptions used to develop the Human Health Risk Assessment included both current exposures (off-site residents and trespassers) and potential future exposures (off-site resident adult/child). There are no changes in these assumptions for 2009.

2. Changes in Toxicity and Other Contaminant Characteristics – (*Carcinogens Groundwater*)

a. There have been no changes in the cancer slope factor (CSF) for chloromethane, 1,2-dichloroethane, methylene chloride, and 1,1,2-trichloroethane. These risks will remain the same for the groundwater pathway.

b. The COCs (Benzene, 1,1-dichloroethane. 1,1-dichloroethene, tetrachloroethene and trichloroethene) have new or revised toxicity values. A recalculation of risks was performed comparing the original toxicity values from the original BRA and the revised toxicity values currently recommended by EPA. For carcinogenic risks, the new or revised slope factors increased or decreased the overall risk value for each receptor. For the most sensitive receptor, the adult/child resident, the total groundwater ingestion risk decreased from 1E-2 to 9E-4, which still exceeds EPA's acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$. The cleanup levels identified in the ROD were recalculated based on the new or revised toxicity values and they are still within EPA's risk range.

Table A: Groundwater (Carcinogens)

Compound	Change in CSF	Risk (increase or decrease)	Remedial Level 1991 ROD (ug/L)	Recalc risk from 1991 RL	New Risk within EPA risk range (Y/N)
Benzene	**YES**	increase	5	3.40E-06	**YES**
Chloromethane	same	same	-	-	-
1,1-dichloroethane	**NTV**	increase	350	2.40E-05	**YES**
1,1-dichloroethene	**YES**	decrease	-	-	-
1,2-dichloroethane	same	same	-	-	-
methylene chloride	same	same	-	-	-
tetrachloroethene	**YES**	increase	5	3.30E-05	**YES**
1,1,2-trichloroethane	same	same	-	-	-
trichloroethene	**YES**	increase	5	8.00E-07	**YES**

NTV - new toxicity value

3. Changes in Toxicity and Other Contaminant Characteristics – (*Non-carcinogens Groundwater*)

a. There have been no changes in the Reference Dose (RfDs) for methylene chloride, tetrachloroethene and 1,1,2-trichloroethane. These HQs will remain the same for the groundwater pathway.

b. The COCs (Acetone, Benzene, 2-Butanone, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, 1,2-dichloroethene (mixed) and 1,1,1-trichloroethane) have new or revised toxicity values. A recalculation of hazards was performed comparing the original toxicity values from the original BRA and

the revised toxicity values currently recommended by EPA. For non-carcinogenic hazards, the new or revised reference doses increased or decreased the overall HQ value for each receptor. For the most sensitive receptor, the adult/child resident, the total groundwater ingestion hazard decreased from 5.62 to 1.47 which is above EPA's acceptable hazard index of 1.0 for non-carcinogenic effects. The cleanup levels identified in the ROD were recalculated based on the new or revised toxicity values and they are still less than 1.0.

Table B: Groundwater (Non-carcinogens)

Compound	Change in RfD	HQ increased (Y/N)	Remedial Level 1991 ROD (ug/L)	Recalc HQ from 1991 RL	New HQ <1.0 (Y/N)
Acetone	YES	decrease	-	-	-
Benzene	NTV	increase	5	0.036	YES
2-Butanone	YES	decrease	-	-	-
1,1-dichloroethane	YES	decrease	-	-	-
1,1-dichloroethene	YES	decrease	-	-	-
1,2-dichloroethane	NTV	increase	5	0.007	YES
1,2-dichloroethene (mixed)	YES	increase	7	0.022	YES
methylene chloride	same	same	-	-	-
tetrachloroethene	same	same	-	-	-
1,1,1-trichloroethane	YES	decrease	-	-	-
1,1,2-trichloroethane	same	same	-	-	-

NTV - new toxicity value

4. Changes in Toxicity and Other Contaminant Characteristics – (*Carcinogens Soil*)

a. There have been no changes in the cancer slope factor (CSF) for 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, methylene chloride, bis-2-ethylhexylphthalate and toxaphene. These risks will remain the same for the soil pathway.

b. The COCs (1,2-dichloropropane, styrene, tetrachloroethene, trichloroethene, vinyl chloride, and PCB) have new or revised toxicity values. A recalculation of risk was performed comparing the original toxicity values from the original BRA and the revised toxicity values currently recommended by EPA. For carcinogenic risks, the new or revised slope factors increased or decreased the overall risk value for each receptor. For the most sensitive receptor, the adult/child resident, the total soil ingestion/dermal risk decreased from 2E-5 to 5E-6, which is within EPA's acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$. The cleanup levels identified in the ROD were recalculated based on the new or revised toxicity values and they are still within EPA's risk range.

Table C: Soil (Carcinogens)

Compound	Change in CSF	Risk (increase or decrease)	Remedial Level 1991 ROD (ug/kg)	Recalc risk from 1991 RL	New Risk within EPA risk range (Y/N)
1,1,2-trichloroethane	same	same	-	-	-
1,1,2,2-tetrachloroethane	same	same	-	-	-
1,2-dichloropropane	**YES**	decrease	-	-	-
methylene chloride	same	same	-	-	-
styrene	**YES**	decrease	-	-	-
tetrachloroethene	**YES**	increase	1.6	2.7E-06	yes
trichloroethene	**YES**	increase	0.5	2.0E-08	yes
vinyl chloride	**YES**	decrease	-		
bis(2-ethylhexylphthalate)	same	same	-		
toxaphene	same	same	-		
PCB-1254	**YES**	decrease	-		

5. Changes in Toxicity and Other Contaminant Characteristics – (Non-*Carcinogens Soil*)

   a. There have been no changes in the Reference Dose (RfDs) for 1,1,2-trichloroethane, ethylbenzene, methylene chloride, styrene, tetrachloroethene, butylbenzylphthalate, di-n-butylphthalate, and bis-2-ethylhexylphthalate. These HQs will remain the same for the soil pathway.

   b. The COCs (1,1,2,2-tetrachloroethane, 1,2-dichloroethene (mixed), vinyl chloride, 1,2,4-trichlorobenzene, di-n-octylphthalate, and PCB-1254) have new or revised toxicity values. A recalculation of hazards was performed comparing the original toxicity values from the original BRA and the revised toxicity values currently recommended by EPA. For non-carcinogenic hazards, the new or revised slope factors increased or decreased the overall HQ value for each receptor. For the most sensitive receptor, the adult/child resident, the total soil ingestion/dermal hazard index increased from 0.005 to 0.133, which is below EPA's acceptable hazard of 1.0, for noncarcinogenic effects. The cleanup levels identified in the ROD were recalculated based on the new or revised toxicity values and they are still within EPA's risk range.

Table D: Soil (Non-Carcinogens)

Compound	Change in RfD	HQ (increase or decrease)	Remedial Level 1991 ROD (ug/L)	Recalc HQ from 1991 RL	New HQ <1.0 (Y/N)
1,1,2-trichloroethane	same	same	-	-	-
1,1,2,2-tetrachloroethane	**YES**	increase	-	-	-
1,2-dichloroethene (mixed)	**NTV**	increase	2.1	0.002	yes
ethylbenzene	same	same	-	-	-
methylene chloride	same	same	-	-	-
styrene	same	same	-	-	-
tetrachloroethene	same	same	-	-	-
vinyl chloride	**NTV**	increase	-	-	-
1,2,4-trichlorobenzene	**YES**	decrease	-	-	-
butylbenzylphthalate	same	same	-	-	-
di-n-butylphthalate	same	same	-	-	-
di-n-octylphthalate	**YES**	decrease	-	-	-
bis(2-ethylhexylphthalate)	same	same	-	-	-
PCB-1254	**NTV**	increase	-	-	-

6. Changes in the Remedial Levels for COCs in Groundwater:

COCs	1991[a] Max Conc. Detected (µg/L)	1991[a] Rem Levels from ROD (ug/L)	1991[a] Rem Exceeded (Y/N)	2004[b] Second 5-Year Review MCLs	2004[b] Second 5-Year Review MCLs Exceeded (Y/N)	2009[c] 5-Year Review MCLs	2009[c] 5-Year Review MCLs Exceeded (Y/N)	2009[d] Regional Screening Level (µg/L)	2009[d] Health Regional Screening Level? (Y/N)
Acetone	1.8E+01	3.5E+02	no	N/A	N/A	N/A	N/A	2.2E+03	no
Benzene*	1.1E+01	5.0E+00	YES	5.0E+00	YES	5.0E+00	YES	N/A	-
2-Butanone	1.3E+01	2.0E+03	no	N/A	no	N/A	N/A	7.1E+02	no
Chloromethane	2.6E+01	6.3E+01	no	1.0E+02	no	N/A	N/A	1.8E+00	YES
Chloroform*	1.0E+01	1.0E+02	no	1.0E+02	no	N/A	N/A	N/A	-
1,1-dichloroethane	1.2E+02	3.5E+02	no	N/A	no	N/A	N/A	2.4E+00	YES
1,2-dichloroethane	2.9E+02	5.0E+00	YES	5.0E+00	YES	5.0E+00	YES	N/A	-
1,2-dichloroethene (mixed)	N/A	7.0E+00	N/A	N/A	no	N/A	N/A	3.3E+01	-
1,2-dichloroethene* (cis)	2.2E+03	7.0E+01	YES	7.0E+01	YES	7.0E+01	YES	N/A	-
1,2-dichloroethene* (trans)	3.1E+01	1.0E+02	no	1.0E+02	no	1.0E+02	no	N/A	-
methylene chloride*	1.1E+02	5.0E+00	YES	5.0E+00	YES	5.0E+00	YES	N/A	-
tetrachloroethene*	2.0E+02	5.0E+00	YES	5.0E+00	YES	5.0E+00	YES	N/A	-
1,1,1-trichloroethane*	3.4E+03	2.0E+02	YES	2.0E+02	YES	2.0E+02	YES	N/A	-
1,1,2-trichloroethane*	1.8E+01	5.0E+00	YES	5.0E+00	YES	5.0E+00	YES	N/A	-
trichloroethene	7.2E+02	5.0E+00	YES	5.0E+00	YES	5.0E+00	YES	N/A	-

[a]1991 Remediation Levels from the 1991 ROD.
[b]2004 Second 5-Year Review MCLs based on 2003 MCLs (EPA, 2003a).
[c]2009 5-Year Review MCLs based on 2003 MCLs (EPA, 2003a).
[d]2009 Regional Screening Levels for tapwater corresponds to a 10^{-6} risk level for carcinogens or a Hazard Quotient (HQ) of 1 for non-carcinogens (EPA, 2008).
*MCLs from the 1991 ROD.

a. No changes have occurred in the MCLs for the following COCs (benzene, 1,2-dichloroethane, cis-1,2-dichloroethene, trans-1,2-dichloroethene, chloroform, methylene chloride, tetrachloroethene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethene) from the original 1991 ROD to 2009. The cleanup goals based on the current MCLs are still valid for these COCs.

b. Acetone - The original cleanup goal of 350 ppb was derived from an EPA reference dose (RfD). The current RfD in IRIS has not changed since the original calculation. By comparison, the tap water RSL is 2,200 ppb. The maximum detect did not exceed the 1991 ROD cleanup goal nor does it exceed the current RSL and may be dropped from the list for further monitoring.

c. 2-Butanone - The original cleanup goal of 2,000 ppb was derived from an EPA reference dose (RfD). The current RfD in IRIS has not changed since the original calculation. By comparison, the tap water RSL is 710 ppb. The maximum detect did not exceed the 1991 ROD cleanup goal nor does it exceed the current RSL and may be dropped from the list for further monitoring.

d. Chloromethane – The original clean up goal of 63 ppb was chosen to be representative of a one in one hundred thousand (10^{-5}) excess cancer risk. By comparison, the tap water RSL is 1.8 ppb. The maximum detect (26 ppb) did not exceed the 1991 ROD cleanup goal however it is above the tap water RSL at the 1E-6 cancer risk level, but within the EPA target cancer risk range (1E-6 to 1E-4).

e. 1,1-dichloroethane – There is uncertainty associated with this standard. The original cleanup goal of 350 ppb was derived from an EPA reference dose (RfD) with a 10-fold safety factor. There is not currently an RfD available on EPA's IRIS. Under the IRIS carcinogenicity assessment for lifetime exposure, the weight-of evidence characterization is "C" for possible human carcinogen. By comparison, the tap water RSL is 2.4 ppb. The maximum detect (120 ppb) did not exceed the 1991 ROD cleanup goal however, it is above the tap water RSL at the 1E-6 cancer risk level, but within the EPA target cancer risk range (1E-6 to 1E-4).

f. Dichloroethylene, 1,2- (Mixed Isomers) – In the 1991 ROD, the cleanup goal is 7 ppb, based on unknown origin of value. No maximum concentration is identified in the 1991 ROD for this constituent.

7. Conclusions - Soil
It is recommended that no changes to the reviewed remediation levels be made. The cleanup levels identified in the ROD were recalculated based on the new or revised toxicity values and they are still within EPA's risk range.

8. Conclusions - Groundwater
The 2nd Five-Year Review (2004) recommended that 1,1-dichloroethane, 2-butanone, acetone, and chloromethane be reevaluated to determine if changes to the reviewed cleanup goals need to be made. These COCs were evaluated in this Five-Year review and it is recommended that no changes to the reviewed remediation levels be made. The cleanup levels identified in the ROD were recalculated based on the new or revised toxicity values and they are still within EPA's risk range.

If I can be of any further assistance or if you have any questions, please call me at 404 562 9176.

References:

EPA 2002e. Supplemental Guidance to RAGS: Region 4 Bulletins, Human Health Risk Assessment Bulletins. EPA Region 4, Website version last updated May 2000. [http://www.epa.gov/region4/waste/oftecser/healtbul.htm]

EPA 2003a. List of Drinking Water and Contaminant MCLs. US Environmental Protection Agency. EPA 816-F-02-013. July. http://www.epa.gov/safewater/mcl.html#8. Website accessed April 2009.

EPA, 2003b. *Memorandum Human Health Toxicity Values in superfund Risk Assessments*, [OSWER Dir #9285.7-53]; December 5, 2003. http://www.epa.gov/oswer/riskassessment/pdf/hhmemo.pdf

EPA 2008. Regional Screening Levels for Chemical Contaminants at Superfund Sites, Interagency Agreement between EPA Office of Superfund and Oak Ridge National Laboratory, http://epa-prgs.ornl.gov/chemicals/index.shtml

EPA-PROV. EPA provisional toxicity values support document available on request from Technical Support Section, EPA Region 4.

HEAST, 1997. Health Effects Assessment Summary Tables, FY 1997 Update, Office of Solid Waste and Emergency Response, USEPA, July 1997.

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Item 2

ARARs Table from the 1991 Record of Decision (ROD)

Medley Farm NPL Site, Gaffney, SC

TABLE 20
POTENTIAL LOCATION - SPECIFIC ARARs
MEDLEY FARM SITE

SITE FEATURE/LOCATION	CITATION	REQUIREMENT SYNOPSIS	CONSIDERATION IN THIS FS
		FEDERAL	
Within 61 meters (200 feet) of a fault displaced in Honocene time	40 CFR 264.18(a)	New treatment, storage, or disposal of hazardous waste prohibited; applies to RCRA hazardous waste; treatment, storage, or disposal.	Not an ARAR since Site is not within 200 feet of a fault displaced in Honocone time.
Within 100-year flood plain	40 CFR 264.18(b)	Facility must be designed, constructed, operated, and maintained to avoid washout; applies to RCRA hazardous waste; treatment, stored, or disposal.	Not an ARAR since Site is not in a 100-year flood plain.
Within flood plain	Protection of floodplains (40 CFR 6, Appendix A); Fish and Wildlife Coordination Act (16 USC 661 et seq.); 40 CFR 6.302; Flood plains Executive Order (EO 11988)	Action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values; applies to action that will occur in a flood plain, i.e., lowlands, and relatively flat areas adjoining inland and coastal waters and other flood prone areas.	Not an ARAR since Site is not in a flood plain.
Within area where action may cause irreparable harm, loss or destruction of significant artifacts	National Historical Preservation Act (16 USC Section 469); 36 CFR Part 65	Requires that action be taken to recover and preserve artifacts when alteration of terrain threatens significant scientific, prehistorical, historical, or archaeological data.	Not an ARAR since Site is not a designated archaeological area.

TABLE 20 (CONTINUED)
POTENTIAL LOCATION - SPECIFIC ARARs

SITE FEATURE/LOCATION	CITATION	REQUIREMENT SYNOPSIS	CONSIDERATION IN THIS FS
Critical habitat upon which endangered species or threatened species depends	Endangered Species Act of 1973 (16 USC 1531 et seq.); 50 CFR Part 200, 50 CFR Part 402; Fish and Wildlife Coordination Act (16 USC 661 et seq.); 33 CFR Parts 320-330	If endangered or threatened species are present, action must be taken to conserve endangered or threatened species, including consultation with the Department of Interior.	Not an ARAR since Site does not have endangered or threatened species.
Wetlands	Clean Water Act Section 404; 40 CFR Part 230, 33 CFR Parts 320-330	For wetlands as defined by U.S. Army Corps of Engineers regulations, must take action to prohibit discharge of dredged or fill material into wetlands without permit.	Not an ARAR since Site is not in a wetlands are and no bodies of water or wetlands are to be modified.
	40 CFR Part 6, Appendix A	For action involving construction of facilities or management of property in wetlands (as defined by 40 CFR Part 6, Appendix A, section 4(j)), action must be taken to avoid adverse effects, minimize potential harm, and preserve and enhance wetlands, to the extent possible.	Not an ARAR since Site is not in a wetlands area.
Wilderness area	Wilderness Act (16 USC 1131 et seq.); 50 CFR 35.1 et seq.	For Federally-owned area designated as wilderness area, the area must be administered in such manner as will leave it unimpaired as wilderness and to preserve its wilderness.	Not an ARAR since Site is not in a wilderness area.
Within area affecting national wild, scenic, or recreational river	Wild and Scenic Rivers Act (16 USC 1271 et seq.); section 7 (a)); 40 CFR 6.302(e)	For activities that affect or may affect any of the rivers specified in section 1271(a), must avoid taking or assisting in action that will have direct adverse effect on scenic river.	Not an ARAR since Site is not on or near a scenic river.
Classification and potential use of an aquifer	* Guidelines for Ground Water Classification, EPA Ground Water Protection Strategy. (USEPA, 1984; USEPA, 1986)	Consider Federal and State aquifer classifications in the assessment of remedial response objectives.	TBC since drinking water wells have been installed and used in the vicinity of the Site. Note that this is not an ARAR but is USEPA policy and therefore falls into the category of other criteria or guidelines to be considered (TBC).
STATE			
Within 100-year flood plain	S.C. R.61.264.18 (b)	Facility located within a 100-year flood plain must be designed, constructed, and maintained to permit washout of any waste materials.	Not an ARAR since Site is not in a 100-year flood plain.
Wetlands	S.C. Pollution Control Act	Facility must not be located in a wetland.	Not an ARAR since Site is not in a wetlands area.